

INTERNATIONAL COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE
in its capacity as elected Office

Best Available Copy

| | |
|--|--|
| Date of mailing (day/month/year) 27 August 2001 (27.08.01) | |
| International application No. PCT/US00/27681 | Applicant's or agent's file reference 0887-4151PC |
| International filing date (day/month/year) 06 October 2000 (06.10.00) | Priority date (day/month/year) 08 October 1999 (08.10.99) |
| Applicant GU, Jiang et al | |

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
07 May 2001 (07.05.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

| | |
|---|--|
| The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland | Authorized officer Christelle CROCI |
| Facsimile No.: (41-22) 740.14.35 | Telephone No.: (41-22) 338.83.38 |

VIRTUAL TELEMICROSCOPE

Attached to this application as Appendix A is a print-out of software code applicable to the embodiments of the invention described herein.

BACKGROUND OF THE INVENTION

This invention is related to a "Virtual Telemicroscope" (VT) system and, more particularly, to a method and system for using a computer system as a telemicroscope.

Telepathology is a field that combines the disciplines of pathology, computer science and telecommunication. It captures, digitizes, transmits, displays and manipulates pathological and medical images for the purpose of analysis, consultation, collaboration, diagnosis, training and standardization. Compared with conventional pathology, telepathology is more efficient, economical and flexible. It enables medical image evaluation to be performed at any location, any time, as long as the evaluator has access to a computer with adequate network connection.

The history of telemedicine and telepathology goes back to the early days of computer science and telecommunication, and its progress has paralleled the advancement of these two fields. Physicians have long been experimenting with the idea of delivering medical service to distant locations by means of telecommunication.

Telemedicine has come a long way. Certain disciplines, such as teleradiology, have been successfully implemented in many hospitals throughout the world. However, telepathology and telemedicine face a number of obstacles. These include computer speed and capacity, programming techniques, compression strategy, network transmission bandwidth, the way the images are displayed and manipulated, physicians' and technicians' training, as well as

administrative issues such as medical licensing, legality, payment, medical insurance, patient privacy, etc.

In addition, for telepathology in particular, much of the resistance to these new technologies from the pathology community has been that the microscopic images have been handled and viewed in a way that is very different from the traditional manner in which the cases are evaluated. The transmitted images are usually static, isolated, and often represent only portions of the entire tissue section. The pathologists frequently hesitate in making any pathologic diagnosis based on the computer images of a partial tissue section displayed in an unfamiliar manner. When the entire specimen is digitized, the process takes a considerable amount of time (a few hours), involving specially designed and expensive automatic microscopic equipment and lengthy scanning steps. This, together with the limited computer capacity, the relatively narrow transmission bandwidth and the very high cost, has hindered the practical value of this potentially very useful technology up to the present day.

With the recent development of fast computers, wide band transmission network and new programming technology, this situation is rapidly changing. This VT system takes advantage of recent advancements and overcomes some of the major technical obstacles in telepathology. It aims to popularize this technology with a new approach.

In an international conference on telepathology on December 3-5, 1996, leading experts in the field of telepathology agreed that at sufficient resolution, the digitized computer images can be adequate for pathological diagnosis and consultation. There are systems for similar purposes. However, no practical system was available to provide a pathologist with a full magnified or non-magnified view of the entire specimen and at the same time a desired view of

selected portions of the specimen at a different magnification. The available systems rely on remotely controlled microscope and camera and broadband network connection, or lengthy process of digitization of slides, involving cost far beyond the justification of the practical value for most pathologists worldwide.

SUMMARY OF THE INVENTION

In accordance with the invention, there is provided a method and a system of using a computer system as a telemicroscope. Among the exemplary aspect of the invention, a first image corresponding to an area of a specimen is captured with a digital image capturing device; at least one second image corresponding to a selected area of the first image is captured with the digital camera, said second image having a different magnification from the first image; the first and second images are stored in a computer-readable medium; and a linking information map is generated indicating the relationship between said first and second images.

In accordance with another exemplary aspect of the invention, a location for an index file is received from a user, wherein the index file is stored on a computer-readable medium; the index file is retrieved, wherein the index file lists a plurality of image files having an image of a specimen and map information of linked images; the listing of the plurality of image files from the index file are displayed on the monitor screen of the user's computer system; a first file name comprising an image of the entire specimen is received from the user, wherein the first file name is linked to a second file name comprising an image of a selected area of the specimen, wherein said image of said second file name has a different magnification level from the image in said first file name; and the images of said first and second file name are dynamically displayed allowing a user to view the specimen with different magnification levels of the specimen.

In accordance with yet another exemplary aspect of the invention, a plurality of images of a specimen are captured. The images correspond to an area of the specimen and one or more segments of the specimen. The images corresponding to the specimen segments have different magnification levels; a linking map is generated between said segment images. The linking map comprises information regarding geographical location of the images in relation to the specimen's structure; and such images and said linking map are transmitted to a remote user via a computer network, thereby allowing the user to view the specimen image in their entirety and at different areas of the entire images with different magnification levels.

For a complete understanding of the invention, together with its features, details and advantages, reference should be made to the following description of preferred embodiments and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 is a diagram of the functional structure of the VT system according to the present invention;

Fig. 2(a) is a flowchart illustrating the major steps in image arrangement, packaging and posting;

Fig. 2(b) is a flow chart illustrating the major steps in image retrieval, reviewing and manipulation;

Fig. 3 is a pictorial representations of the hardware set up of a VT system showing the process of image acquisition using a high-resolution scanner, a light microscope with a digital camera and a computer;

Figs. 4a, 4b are screen views of image arrangement, linkage, and packaging. The image selection view (Fig. 4a). The image link and arrangement view (Fig. 4b);

Fig. 5 is a screen view of image retrieval;

Fig. 6 is a screen view of the automatically hidden toolbar and its icons;

Fig. 7 is a screen view of the magnifying glass effect;

Fig. 8 is a screen view of the microscope effect;

Fig. 9 is a screen view of the linked image map;

Fig. 10 is a screen view of the measurement function;

Figs. 11a-11j are flowcharts of the major functions of the VT program; and

DETAILED DESCRIPTION OF THE INVENTION

1. Basic Principles

The present invention is a new "Virtual Telemicroscope (VT) system", in which images are captured, digitized, arranged, packaged, posted, transmitted, displayed, enlarged, measured and analyzed with a user-friendly software program. It can be used for telepathology, telemedicine, distance learning, remote training, standardized exam and other applications, in which high-resolution images are transmitted and evaluated. This invention enables the users to retrieve and view virtual slides with specimen images and logically linked high-resolution partial images anywhere, any time via the Internet and other computer networks, without involving special and expensive equipment and setup.

Fig. 1 shows a functional structure of the VT system according to the present invention, which can be used to create, retrieve and view virtual slides. The basic principle of this system closely mimics that of a light microscope. When a pathologist exams a specimen on a glass slide

under a light microscope, he uses a number of objective lens with different magnifications. Each slide is viewed through a fixed magnification. By moving the glass slide on a movable stage, the entire slide is examined.

He usually views the slide with a low-power objective lens first to exam the entire specimen and then switches to a higher-power objective lens to have a closer look at different areas of interests. Essentially, he views static images in a dynamic manner. The VT system works the same way. It captures the image of a entire slide with a high-resolution scanner. Alternatively, a low-power objective lens connected with a digital image capturing device such as digital camera can be used for the image of the entire slide. Subsequently, high-power images are captured for selected areas with several high-power resolution lens with different magnification also connected with the digital image capturing device. The captured images are converted into a digitized images and stored. A link map information is then generated to link the image of the entire slide to the higher-power images. All these images, information concerning their location relative to specimen and magnifications, together with associated text data are then packaged and transmitted to a remote computer accessible by a user.

The remote computer displays the entire slide as a first image and a higher-power close-up views as a second image, as well as an image map that indicates the relationship between the first and second images. The relationship can be one or more of the degree of magnifications, size of the specimen represented by the image location of the selected area of the specimen from which the second image was prepared. The second image can be prepared as many as possible with different selected area and magnifications. The viewer can view different portions of the digitized images and enlarge them to a range of magnifications without loosing any clarity.

In summary, static images of different magnification lens and of corresponding different areas or sections from the same specimen are captured, arranged and packaged. They are then transmitted and viewed by a remote computer in a dynamic way, i.e. the viewers can examine the entire slide and then switch to selected higher-power images for a close-up evaluation. The viewer can also navigate the "virtual" slide in a way very similar to operating a light microscope. In addition, the VT system can perform image measurement, comparison, annotation, etc. and provide functions beyond those provided with a light microscope.

Fig. 3 shows pictorially a representative hardware set-up of the VT system. As an example, the following equipment is used; (1) a 166 MHz Pentium II or above class computer with at least 128 MB of RAM installed memory (384 MB recommended), 100 MB of available hard disk space, CD-ROM drive, Color monitor capable of 800 x 600 resolution (19 inch recommended), Windows 95, 98, NT or 2000, Internet or Intranet connection (broadband connection recommended); (2) a digital camera for a light microscope capable of capturing images of at least 800 x 600 pixels resolution (1152 x 864 pixels or higher resolution recommended); (3) a high-resolution slide scanner that can scan standard pathological glass slides at 2700 x 2700 dpi (4000 x 4000 dpi or higher recommended).

Fig. 3 illustrates the process of image acquisition using a high-resolution scanner, a light microscope with a digital camera and a computer. An image of the entire specimen is first captured with a high-resolution slide scanner or a light microscope using an objective lens at a very low magnification. This image of the entire specimen slide is used as the background image of the virtual slide. Higher-power images are then captured with the microscope and the digital camera from different areas of the same specimen using different objective lenses. All

acquired images are saved in a folder containing logically-related image data in a computer. The VT program packages them into a virtual slide for transmission and viewing.

The VT system can be divided into the following six operational stages: acquire images, package images, transmit and retrieve images, display images, manipulate images and provide information feedback. Physically, the VT system comprises a memory unit and processing unit. The processing unit is in communication with the memory unit and is configured by the processor to perform such functions as capturing and storing images, generating and storing a link map between the images and transmitting the stored information to other users at remote computers through computer network.

As noted above, an image of the entire specimen on the glass slide is captured with a high-resolution scanner or, alternatively a digital camera and light microscope equipped with a low-power objective lens. This image is usually very large in size, much more than the usual computer screen size (800 x 600 pixels). Then, areas of interests from the same glass slide will be captured with a digital camera linked to a light microscope equipped with higher-power objective lenses. Preferably, additional images will be taken from different specimen areas at different magnifications from the same glass slide. All these images are captured in sizes equal to or larger than 800 x 600 pixels and saved in JPG format into the data file folder in the computer. Additional slides can be prepared in the same manner.

The VT program packages these saved images for transmission or posting. This is achieved by using the first image (the image of the entire specimen) as a background map and arranging all the other images taken from the same slide against this background. These images (as thumbnails) are digitally placed on the background map and positioned at the locations where

they were captured. Their sizes will also be digitally adjusted to reflect their magnifications, i.e., the higher the magnification, the smaller the area they will cover on the background map.

Information including the images themselves, the locations and the image sizes, together with associated text data is saved and packaged into an index file. At this point, the VT program makes small thumbnail images of all the large images. The image files and the index file will then be posted on a computer server or sent to the receiver via email attachment. This completes the task for image preparation at the sending side of the system.

On the receiving side, a remote viewers will open up the VT program on his/her computer system and enter the complete address where the packaged images are posted. By clicking the "retrieving" button or the "enter" key, the VT program will retrieve the file names of the saved images and link information map. The retrieved files are shown as thumbnail images on the screen allowing a user to easily select an image out of several images shown. A thumbnail image on the screen represent a "slide tray" and the screen may can show up to 20 virtual slides simultaneously in an embodiment. The user can then see all the available images as virtual slides on the monitor screen. If the image package is transmitted to the remote computer via an e-mail attachment, the viewer will only need to locate the file on his computer. Once the file name is selected, the packaged images will be called it into the VT program for display.

The user picks any slide displayed on the screen for review by clicking on it. The image of the entire specimen (the one captured with the scanner or the low-power objective lens of the microscope connected with digital camera) will then be downloaded into the user's computer and displayed on the screen. The real size of the image (e.g., 2000 x 2000 pixel) is much larger than

the monitor screen (800 x 600 pixels). At this point, the program shrinks the large image to fit into the size of the screen so that the reviewer can have a complete view of the entire specimen.

At this point, a viewer has a number of options. The viewer can choose one of the many functions built into the VT system, including evaluating the image with the "magnifying glass function", the "microscope function", the "measurement function", "retrieving text data" associated with the images, and retrieve additional high-power linked images to have a closer look of selected areas of interests from the same specimen. The viewer may also go back to the "virtual slide tray" to select another slide to view, as if working at an office desk with a slide tray and a light microscope. All such functions can be activated by "clicking" on corresponding icons in an automatically hidden toolbar, which is located at the upper margin of the screen.

The principle of the enlargement functions of the VT system is based on the fact that the original sizes of the captured images are very large, much larger than that of the screen size (800 x 600 pixels). The VT program manipulates the image to show only a portion of it at different ratios of sizes from the original image, and gives the viewers the impression of image enlargement. This is why the enlarged images are always sharp. The degree of enlargement is determined by the original size of the captured image.

In the magnifying glass effect, only a portion of the enlarged image is shown, mimicking the effect of a magnifying glass. In the microscope mode, a small portion of the virtual slide, as defined by a virtual objective lens, is displayed on the entire screen as the viewfinder, closely mimicking the effect of a light microscope.

A viewer can also click an icon to view the availability of the linked higher power images, together with their relative locations and sizes. By clicking on these linked images on

the image map, the viewers can selectively evaluate these linked higher power images to have a better appreciation of the detailed structure of the specimen.

By selecting different icons in the toolbar, viewers can also perform line measurement of images, view associated text files, compare one image with other images in an established image database, and view the help file. The viewers can exit the program by clicking the "quit" button at any time.

The basic functional organization of the VT system is illustrated in Fig. 1. The different steps involved in operating of the VT system is presented in Figs. 2a, 2b. The logical steps of the computer program are presented in the flow chart of Fig. 11. Details of each aspect of the system are described below.

2. Image acquisition

A pathological tissue section is first converted into a digital image by capturing with a digital microscopic camera or a high-resolution scanner. In either case, the entire pathological image can be digitized. The basic functional relationship among the slide scanner, the digital camera and computer in capturing the images is illustrated in Figure 3.

Depending on the objective lens used on the microscope, the entire image may be captured with one exposure or with a series of exposures of the tissue section and then a complete image formed by pasting multiple images together with software to make a seamless mosaic image. The low-power overview image also can be obtained with microscopic objectives at very low magnification.

Generally, it is easier to capture the image of the entire specimen with a high-resolution scanner. Currently, the highest resolution for a small area glass slide scanner is about 4000 x

4000 dpi. For a 0.5 x 0.5 inch tissue section, this will generate an image of about 2000 x 2000 pixels in size. When displayed on a computer monitor at 800 x 600 pixels with a 19-inch diagonal displaying area, this represents a real enlargement of the original sample at about 100-150 times.

On a computer monitor with a display capacity of 0.26-0.28 mm resolution, images at their real size can be further stretched 1.5 times without losing any visible resolution. When stretched beyond this magnitude, the quality of the image begins to deteriorate, and this may affect the accuracy of the pathologists' evaluation of the images. Therefore, with a high-resolution scanner, a tissue section can be effectively enlarged up to about 200 times from the original size without any visible distortion of the original image. This would magnify a typical human neutrophil (originally at about 15 μ m in diameter) to about 3-4 mm in diameter, enough to display microscopic patterns of cellular arrangement for most pathological cases. Slide scanner at other resolutions can also be used. However, the final size of the captured image preferably should be equal to or larger than 800x600 pixels.

Once the entire specimen is captured, one can further capture a number of high-resolution images from different areas of interest from the same slide using microscopic objective lens of higher magnifications. Each image should have the resolution of at least 800x600 pixels, preferably higher. These images can be arranged, linked and packaged together with the low-power image captured previously.

They will be transmitted collectively and viewed at the receiving end in a meaningful way to make sense of each high-power image in relation to each other and to the low-power image as the background. This will greatly enhance the effectiveness of image viewing by the

remote computer. At the same time, this approach will save the user from capturing the entire slide with high-power objective lens, which consumes time and storage space and slows the entire process to an impractical level.

Once captured, the digital images can be saved into jpg, gif, tif or bmp file format. Depending on the file format, the file size of each high-resolution image varies, from less than one megabyte to several megabytes. To facilitate fast network transmission, it is recommended that the images be saved as jpg files with about 50 % compression. We have determined, through experiments and consultation with other pathologists, that at this rate of compression, there is no noticeable loss of image clarity. Further compression may be possible for different types of files. These images can be stored in any folder and drive, portable or fixed, in a computer for further packaging, posting and transmission.

3. Image preparation, packaging and posting

The captured images need to be arranged, packaged and saved into designated folders. Fig. 2a shows the major steps of image arrangement, packaging and posting. These packaged and saved files can be posted in a server (on a remote computer or the same computer) for remote retrieval, or in the same computer for local retrieval. The packaged images can also be compressed and attached with an email and sent to any email addresses. The VT program installed in a remote computer can open the email-attached files. This approach will bypass the need to have a computer server at the sending end and make it available to most pathologists and users. The viewing functions of the VT program are the same no matter how the image package is transmitted or retrieved.

If a server is used, the package is posted in certain designated folder that will make the packaged images available for retrieval by the Virtual Telemicroscope program located in the same or remote computers. The remote computers may be stationed across rooms, across nations or across continents, and connected by a network (local area network, Intranet or Internet). One set of packaged images can be retrieved and viewed by unlimited number of computers simultaneously. This feature facilitates online learning, online examination, collaboration, consultation, discussion and standardization.

The packaging function is achieved by grouping and arranging all the images captured from the same glass slide together and record their locations and magnifications. By clicking on the "prepare image" button, a dialogue window of file directory is opened with two columns and a number of function buttons at the middle as shown in Fig. 4a. The image selection window contains two columns with function buttons in the middle. The left column displays available images for packaging. The right column displays images to be made into virtual slide.

The users can navigate through the file directory and identify the previously captured images. Once the folder is selected, file names of all the relevant image files will displayed in the left column. The users can then select the image files to be used as the background images (the ones captures with the slide scanner or the low power objective lens) and add them to the right column for further packaging and processing.

The images of up to 20 different slides can be comfortably processed and presented in a virtual slide tray for the viewer to view. Each of the twenty images can be linked and packaged to additional 20 higher power images taken from the same slide to give the viewers the option to

have a closer exam of selected areas at higher magnifications. This linking and packaging function of the VT system is described below.

A unique feature of this system is that it can arrange a number of images at different magnifications taken from different areas of the same tissue sample and relate them to a background low magnification image in a way that the geographic relationship among the different images and their relative magnifications are recorded, transmitted and displayed.

This feature enables the viewers to use a low-power image of the entire slide as the background and link up to 20 higher-power images (this number can be increased if needed) of different areas to the same background. Each linked image can be positioned and sized on the background to reflect the location and area from where it is taken. This allows the senders and the viewers to appreciate the relationship among the different images taken from the same slide and greatly enhance the easiness for the reviewers to view and analyze the entire specimen.

The linkage and package of multiple images taken from the same glass slide is achieved as following. First the file name of the background image is selected and then click on the button of "link". The selected background image is then displayed on the screen. At this time another file directory window is opened and the users will select the image files to be linked to the background image. When all the higher-power images to be linked to the background image are selected, they will be displayed at the margin of the background image as small thumbnail images as shown in Fig. 4b. The image linkage window contains the entire background image and many higher power images to be linked to the background image. These higher power images are displayed as smaller thumbnail images over the background and their positions can be moved and sizes readjusted with the mouse by the user to create a linked image package within

the virtual slide. Their positions and sizes should correlate to the areas from which they were captured and the ranges of sizes they cover. All these information and the images will be packaged and transmitted. They can then be displayed faithfully in remote computers using the VT program.

The users can then drag and drop each image onto the background and position it to the appropriate location where it was captured. The users will then resize the images by dragging one corner of the linked images and shrink or enlarge them to appropriate sizes in relation to the background image, covering an area equivalent to the viewfinder sizes of the objective lens used in capturing these images. All the linked images are arranged against the background image in the same fashion. The entire package will then be saved. All the images, together with their locations and sizes and relationship to each other, will be recorded in the index file and transmitted to the remote computer for display.

During image packaging, the VT program also offer the possibility for the user to annotate the images by putting arrows, circles, rectangles, lines and words on the images. These marking can be recorded and transmitted to the retrieving computer and displayed by clicking an icon in the toolbar.

During image preparation and posting, the Virtual Telemicroscope program makes copies of the original digitized images and stores them in the designated folder on the server (a remote server or the local computer if it is used as its own server). Simultaneously, the VT program automatically creates an index file that compiles the file names or given names for each image. This file is saved as a Director (Macromedia Inc. San Francisco, CA, USA) cast file with an

"cct", "cst" or "txt" extension. The former file format is protected that can not be opened or modified by a third party.

The VT program will also make thumbnail image from each high-resolution image and store them with the index file for retrieval. During image retrieval, the remote computer can access the designated folder to read this particular index file using the VT program, and display the available images on the remote computer. The images are first displayed as thumbnail images with complete file path and names in a virtual slide tray, resembling the glass slide tray used in routine pathology laboratories. One virtual slide tray can hold up to 20 slides. The viewer can retrieve slide trays one at a time and there is no limit to how many slide tray can be posted and retrieved. These slide trays can also be retrieved and displayed by the same computer where the files are stored. All these functions are performed in the background and are transparent to the users. All the viewers have to do is to enter the path or URL of the folder location, with a click of a button (the retrieval button), or a press of a key (the enter key); the virtual slides will be displayed on the monitor screen almost instantly.

When the packaged images are stored in the same computer, or transmitted as an email attachment, the user will first need to locate these files by clicking the "open file" icon next to the location window. A file directory window will open and allow the user to identify the packaged files. Once selected, the packaged images will be displayed in the screen in the same way as for the retrieved image packages.

The dialogue window for image preparation and posting also calls for optional attachment of data files of related information concerning the image. These can be patients' information, notes from the sender, specific requests, etc. Notes can be entered and files can be

attached at this time. They will be stored under the same names as the image files but with different file extensions. These files are retrieved together with their linked image files.

In the dialogue window during image posting, there is also an entry for a password. The users have the option to enter a password to prevent the images from being accessed by unauthorized parties. If the users choose to leave the password window blank, no password will be required when retrieving images.

There is also an option named "extra security". If the user checks this option during image packaging, the images and data will be encrypted to provide extra protection to third party tampering. This option may slow down the speed at which the packaging is processed by the computer.

By clicking the "save" button, all the images and associated information will be packaged and saved into a local directory or a server. All saved image packages become available for local or remote retrieval. This can be achieved by uploading the files onto a remote server, or by using the default computer as the server with the "Personal Web Server" software from Microsoft, Inc. In the latter case, the saved files should be located directly in, or in subfolders of, the path "c:\webshare\wwwroot\", where "C" is the root drive where the Personal Web Server program is installed. The image files are then available for retrieval by remote computers via a network.

4. Security

There are four levels of security for image transfer. First, the retrieval party needs to know the IP address, domain name and the exact path of the image files on the server in order to retrieve the images. This is a lengthy name or a series of numbers or a combination of both. The

name(s) of the subfolder(s) can be easily controlled and changed by the server administrator, thereby providing the first line of security.

Second, the administrator can move the image files from the designated folders to another location, or change the folder or file names, thus making the folder inaccessible by outside computers. Also, the server computer can be turned off. This will effectively prevent unauthorized user from accessing the files from a remote computer.

Third, the password function is an integrated part of the VT program and can prevent unauthorized users from accessing these image files. Without entering the correct password, the remote computer would not be able to go beyond the first screen even if they have the VT program installed in their computers and know the exact location of these images. The password can be easily changed during image posting. In the event the senders forget the password entered, they can just repost the images with a new password and the old one will be automatically voided as long as the files are saved in the same folder.

Finally the "extra security" function would enhance the security during image storage and transmission.

5. Image retrieval

Fig. 2b is a flow chart that explains the image retrieval process. Image retrieval is performed in two steps. First the retrieving computer sends a signal to the server computer to retrieve the names and the thumbnail images in the index file. The users need to enter the correct URL (for remote computers) or file path (for the default computer), and then the correct password in order to have access to this information located in the server computer. This

retrieval is achieved via the network by reading the index file compiled by the VT program during image preparation and posting.

The file names and thumbnails, each corresponding to one image file on the server, will be displayed on the remote computer as a virtual slide tray, with up to 20 slide per tray. These thumbnail images and names give the viewers a clear indication of the available images and data for retrieval. This process is completed quickly, as at this stage only the index file and the small thumbnail images are retrieved and displayed, and the relatively large files of images have not been transmitted.

Once this is completed, the remote users can then select the desired slide by clicking on it, and the corresponding image package and related data files will be transferred to the remote computer. Depending on the speed of transmission and the size of the files, this step may take less than a second to several minutes. With broad bandwidth Internet connection (cable, T1, T3, DSL, etc.), this step typically takes less than a few seconds. Once a slide is clicked, the entire background image (the one captured by the high-resolution scanner or the low power objective lens) will be displayed on the screen. At the same time, the linked images and all other linked information for this slide continuously download in the background.

A user may also use the "download all" option. Once this button is clicked, all the available images in the slide tray will be downloaded to the user's computer. This process will take longer than download one slide at a time, but will facilitate a faster retrieval and processing speed in subsequent manipulations of the images. Fig. 5 shows an example screen for the image retrieval and shows five virtual slides for selection. The address of the image location on the Internet or local computer should be entered into the address window. The virtual slides will be

retrieved and displayed on the screen on a virtual slide tray. Clicking on any slide will retrieve the virtual slide into the computer. The viewer may also select the "download all" option to download all images into the viewing computer at once.

The retrieval program is compiled with the Lingo language within Director 8.0, using the "GetNetThing" command. This function can also be achieved by using other commands with other computer languages.

6. Image manipulation

Once the image is retrieved, it automatically enters into the internal cast of the VT program and is used as an internal cast number. At the same time, the VT program makes smaller versions of the large, high-resolution images. The smaller images are also entered as internal cast numbers. The original images and their smaller counterparts are then used in the VT program and displayed on the "stage" (the entire visible area of the monitor). For this program the stage is an area of "800 x 600" pixels displayed at the center of the monitor, and should occupy the entire screen. We recommend that the computer monitor be set at a resolution of 800 x 600 pixels. It can be higher but not lower.

At this stage, the entire image is displayed on the monitor without any obstruction by other images, toolbars or dialogue windows. The toolbar, which is located across the top screen margin, is hidden out of sight automatically. An example tool bar is shown in Fig. 6.

The toolbar becomes visible only when the mouse moves to the upper margin of the screen. The icons in the toolbar are dynamically displayed, i.e. they appear only when the particular functions are relevant and available to the particular screen content. It appears whenever the mouse moves close to the upper border of the screen. Icons for all functions are

located in the toolbar. By clicking on the icons in the toolbar, various functions are executed. This automatic hiding of the toolbar serves to maximize the displaying area of the images, ensuring the maximum clarity and the highest magnification possible. The toolbar itself is semitransparent, allowing the image underneath to show through.

Also in the toolbar is a button to call for related patient information and notes. Clicking on the button can display such data on the screen. There is also an "index" button for the users to go back to the virtual slide tray to select another image to exam. Should the users have any question in operating the program, a "help" button is also included in the toolbar. It can be toggled on and off by clicking this button, or the right mouse button from anywhere of the screen. A "tool-tip" will automatically appear when the mouse pauses over an icon for more than one second, providing a simple and clear explanation of the function of the icon in question.

7. Magnifying glass effect

There are three modes of image manipulation - two for viewing and one for measurement. The two viewing functions are the "magnifying glass effect" and the "microscope effect". These can be switched on and off by clicking on the corresponding icons in the toolbar. Clicking on the magnifying glass icon in the toolbar turns on this effect.

Fig. 7 shows an example screen for the magnifying glass. This may be the default mode and appears on the monitor when the image is first displayed on the screen but the magnifying glass itself is hidden. The "magnifying glass lens" can be moved around the screen with the mouse. Its magnifications can also be changed by clicking the up and down arrows in the toolbar. The enlarged images are always sharp.

The magnifying glass is a rectangle frame of about 300 x 200 pixels in size, and can be turned on and off by left clicking the mouse anywhere on the screen, or clicking on the icon of magnifying glass in the toolbar. The magnifying glass appears at the center of the screen as a rectangular shaped "lens", through which the image within the frame is enlarged by about 1.5-5 times from the background. Both the size of the magnifying glass and the degree of image enlargement within the frame can be adjusted by the users to a certain extent. The "magnifying glass lens" can be dragged around on the screen, allowing enlarged viewing of different areas of the background, in a way similar to viewing a detailed map with a hand hold magnifying glass, only that this magnifying glass lens can adjust its viewing size and magnifications. This function satisfies the need for the users to evaluate any region of the image at low magnifications.

The magnifying glass effect is achieved by using the Lingo language to manage the location and visibility of two layers of images, i.e. the larger version in the back and the identical but smaller version in the front, with another invisible layer called a "mask" in the middle. A mask layer enables the image beneath it to show through only partially from the white area. In this case, the white area has a rectangle shape to give the magnifying glass effect.

In the internal cast file, the large image should be positioned immediately after the "mask" layer. The size of the mask determines the size of the magnifying glass. The size of the large image is larger than the screen size. So when it is fit into the entire screen, the image shrinks in size. The magnifying glass can display a portion of the larger version of the same image located beneath the mask layer and use the center of the mask to dynamically align the foreground and background images to correctly display a changing area within the magnifying glass lens as it is dragged across the screen by the viewer. The size of the large, high-resolution

images is used to limit the degree of magnification, so that even at the maximal magnification, the "enlarged" image is not distorted.

8. Microscope effect

Clicking on the microscope icon in the toolbar turns on the microscope effect. Fig. 8 shows an example screen of the microscope effect. The entire slide is now shrunk to the lower right corner of the screen to serve as the "virtual slide". An "objective lens" within the virtual slide is movable with the mouse.

The area within the small objective lens is enlarged and displayed dynamically on the entire screen. This function closely mimics the operation of a light microscope. This is the main viewing function of the VT program. At this mode, the entire image is displayed at the lower right corner of the screen as a smaller image map. This is the smaller copy of the larger, high-resolution image made by the VT program immediately after image retrieval.

The purpose of making this smaller image is to speed up the image loading process. This smaller image serves as a "virtual slide" containing the entire image, while a portion of the larger, high resolution image is displayed on the entire monitor screen as the viewfinder. Within the virtual slide (the smaller image), there is an even smaller, colored rectangular frame with a 2-pixel border. This frame serves as the objective lens. The image area that is encased inside the "objective lens" is enlarged and displayed on the entire screen.

The size of the objective lens can be changed by clicking on the up and down arrow or the prefixed objective lens size icons in the toolbar. The enlarged image of the area defined by the "objective lens" on the virtual slide fills the entire screen and changes magnifications

accordingly. The objective lens can be dragged around within the small image (the virtual slide), and whatever area defined by the objective lens is then displayed instantly on the entire screen.

The smaller image, i.e. the virtual slide, can also be dragged around in the monitor and change sizes. By clicking on the "fixed location icon" in the toolbar, the virtual slide jumps to one of the four corners of the monitor screen, leaving most of the screen for viewing the enlarged area. By clicking on any area outside of the virtual slide, the virtual slide is hidden, leaving the entire monitor free from obstruction for a clear view of the enlarged image of the selected area. The virtual slide can appear anytime by clicking on the left button of the mouse again. This microscopic function, particularly the movement of the objective lens, changing magnifications of the image and the instantaneous displaying of the enlarged images of selective areas on the entire screen, permits further enlargement of the images and closely mimics the manner by which the users evaluate tissue sections on glass slides under a light microscope. When the high-resolution image contains the entire tissue section, this function enables the pathologists to view the entire image at will and offers them the freedom to exam any area of the entire tissue section at a range of magnifications. This affords the users the confidence and ease in operating the system as it functions similar to the traditional microscopic procedure.

The microscope effects are coded by Lingo computer language and image map of the Director 8.0 program. The location, size and movement of the virtual slide, the objective lens and the magnifying glass are continuously traced by identifying the pixel positions of the four-corner coordinates of the images and shapes at all times. In theory, the images can be enlarged indefinitely, but in reality, this is limited by the size of the large image and its ratio to the stage size. The data of the image size is detected at image retrieval, and then compared to the stage

size to derive a ratio. This data is then used to restrain the maximum degree of magnification, so that the image would not be enlarged too much to distort the image, thus preserving the truthfulness of image at the highest magnification.

9. View linked images and relationship map

To view the linked higher-power images, one would click the "linked image" button in the toolbar, where it is displayed as a small open hand. The entire background image together with the linked images will be displayed on the screen. Fig. 9 shows an example screen of the linked image map. By selecting the "linked image" button in the toolbar, the viewer can review all the linked higher power images taken from different areas of the same specimen.

The linked image map displays the entire background image and the relative positions and sizes of all linked higher power images. By clicking on a linked image, the entire high power image will be displayed on the screen for close evaluation. The viewer can go back and forth to view different higher power images at will. This screen now displays the entire slide with available linked higher-power images displayed at different locations with different sizes, clearly illustrating the relationship among all the available images from one specimen. The linked images are first displayed as semitransparent yellow rectangle shadows.

Once the downloading of a linked image is completed, the yellow rectangle will have a red outline. This image can then be clicked to display the linked higher-power image on the entire screen. Once a linked image is displayed, functions of all the tools in the toolbar are still available to view the linked images. When finishing viewing this image, one click of the same "linked image" button will bring back the previous screen displaying the image relationship map. One can then select another higher-power image to display.

The feature of the linked image map allows the viewers to evaluate multiple images taken from the same glass slide at different magnifications in a logical and clear process. The entire slide and the linked higher-power images are organized and displayed in a meaningful manner. An example of the layout of the linked images and relationship map is presented in Fig. 4b. When finishing, the viewers can click the "Index" button in the toolbar, and this will bring back the virtual slide tray for the viewers to select another slide to view.

10. Image analysis function

In addition to viewing the images, the VT system enables the users to directly measure the images on the monitor screen. Fig. 10 shows an example screen for the measurement function. By drawing a line between two points on the screen, the VT program will display the correct length of the measurement. When using specified slide scanner and digital camera, the measurement function is pre-calibrated. Otherwise, it needs to be calibrated when measuring each image.

In the measurement mode, the viewer first calibrates the measurement by drawing a line of any length across the screen and then entering its length and the unit. This is a necessary step as the images are captured at different magnifications at a remote site therefore a standardized unit for all cases is not possible. By defining the distance of two points on the screen, the program can establish a measurement unit for the particular image. This length unit is stored in the computer's memory for further measurements until it is reset. This calibration can be performed by drawing a line across the central dimension of a red blood cells or a neutrophil, which in human samples are known to have fixed lengths of about 7.5 μm and 15 μm respectively.

The calibration can be performed on any other structures on the image with a known distance. The calibration can also be established accurately by measuring particles of standard sizes incorporated into the tissue section, and/or scales engraved or incorporated on the tissue section or the glass slide. Once calibrated, the program will remember the information and use it in all subsequent measurements by recalculating the set value no matter what is the magnification of the image to be measured, until the next calibration is performed.

During calibration, the length and the unit entered by the user is correlated to the pixel information of the line on the screen. This data is then linked to the ratio between the real pixel of the image and the displayed image to take the magnification factor into consideration. The subsequent measurements are performed by multiplying the length of the new line in pixel with the basic unit per pixel established at calibration. This ensures accurate reading of the distance of any two points on the screen at any time at any magnifications of the original image.

This calibration step can be avoided if the user using a scanner with know resolution. The VT program assumes the user employs the recommended high-resolution scanner (Polaroid Sprint4000) with a resolution of 4000x4000 dpi, and has set the default calibration against this enlargement. The program can automatically detect the pixel size of the image, thereby calculate the unit length per pixel. When this scanner is used at this setting, or when a given microscope objective lens is used with fixed resolution, the default calibration will be accurate and used directly without going through the calibration process.

After calibration, to measure the size and distance of any two points on the image at any magnification, the user needs to draw a line with the mouse between any two points on the screen. The correct distance will be calculated and displayed instantly on the screen.

Measurement can be repeated indefinitely until the user clicks any other button to exit the measurement mode.

11. Image database and instant comparison

The VT system also contains an image database with commonly encountered pathological images. These images can be retrieved at any time and be compared with new images in question. This facilitates accurate and effective diagnostic, consulting and learning experience. The users can also enter their own collection of images for future references.

The reference image database does not have to be stored in the same computer where the user is retrieving images. It can be stored in any remote computer at any location as long as it is connected to the Internet. This allows different hospitals to utilize their specialties in setting up different reference image database for universal comparison and standardization.

12. Reporting and feedback function

Once the images are evaluated, the evaluator can communicate with the sender by a number of means, mostly built in the VT program. For example, an email function can be activated within the VT interphase using the computer's default email program. Other functions include videoconferencing, whiteboard image sharing, chat room, Internet phone, etc. These functions enable the sender and the receiver to communicate, and in particular, it allows the receiver to request more images at specified locations and magnifications other than those already provided by the sender.

Some of these functions are achieved through other commercially available software, with "buttons" within the VT program to access these functions. These other functions make the

VT program a complete system for the purpose of conducting telepathology and effective exchange of data and information over the networks.

13. Other applications

Overall, this system is a new concept using new processes and new technologies to accomplish the task of image transmission and evaluation. High-resolution static images are captured, processed and transmitted, but are viewed in an interactive and dynamic fashion. It is very easy to use, flexible, reliable and accurate. The entire system with this new process is much more affordable than any of the other available systems for the same or similar purpose.

This system can also be used to view high-resolution images of gross pathological specimens. The system would give consulting pathologists or on-call pathologists the freedom to render expert opinion on cases from distant locations. The VT system may be used to transmit and view X-ray and other medical images.

This program may create new image viewing capabilities. For example, the program may provide a bridge between the light and the electron microscopic (EM) images by shrinking and displaying a mosaic of EM images on the screen and reducing the magnification to the light microscopic level. The users can then zoom in to any region with the magnifying glass and microscope effects to examine the ultrastructural details without losing any resolution. This would allow the same preparation to be evaluated at both the light and the electron microscopic levels without changing samples or instruments.

With this system, images of gross specimen, light microscopic images and EM images can be bridged, linked and packaged together. The same specimen can be examined at different levels in a logical way with the linked image function. In addition, the VT program can be used

to evaluate any high-resolution, large sized image that needs to be transmitted and viewed dynamically. Such applications may include microscopic examination of computer chips, analysis and close-up viewing of high-resolution satellite images, viewing large maps, measuring distances, and examining detailed photographs of any subject.

A special version of the VT program has been developed to perform morphologic exams for students, residents, etc. In this version, the administrator can set the source where the packaged images are retrieved. A timer can also be set for a time period during which the images will be available for viewing. This information is protected from the students. By clicking on the "start test" button, the timer will start and testing slides will appear on the screen. The students can then select the slides to review and answer relevant questions. When the set time is up, the program will stop and jump to a new screen for the student to exit.

This program has been used at the College of Medicine, University of South Alabama for teaching medical students. The responses have been overwhelmingly positive from the participating students and instructors.

14. Software

The VT program was developed using the multimedia programming Director 8.0 Shockwave Studio. It consists of a stage where the visible elements of the interface for the end users are placed. This is controlled by the backstage scores where the command sequences and relationship among different elements are arranged and displayed.

The individual elements (graphics, text, video, sound, scripts and other programming components) are called casts and are stored in cast libraries. Each cast number can be made into sprites and placed on the stage and/or the scores. Each sprite, cast number, frame or movie (the

entire program is a collection of movies) can be further controlled by scripts using a programming language called Lingo. These commands instruct the behaviors of the sprites, the cast members, the frames and the movies. The end product of the program is packaged into an executable file called a projector, or a compressed file that can be run within an Internet browser called Shockwave movie. These standalone programs and files can be executed by the end users on any computer to perform the designed functions of the program.

The software code in Appendix A illustrates different aspects of this VT program. Page 1 of the Appendix is a printout of the internal cast members where most of the casts are stored. Pages 2-11 of the Appendix are the layout of the backstage scores where the design and arrangement of the sprites are illustrated. Because the score table is very large, it is printed on 11 pages and each page is a continuation from the previous one longitudinally (vertically). The correct sequences of the pages can be identified by the continuity of the channel numbers shown on the left column of the page and they should range from 1 to 300. Pages 12-35 of the Appendix contain a collection of the key script codes written with the Lingo language. Collectively, these documents illustrate the construction of this program.

Although illustrative embodiments of the present invention, and various modifications thereof, have been described in detail herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to these precise embodiments and the described modifications, and that various changes and further modifications may be effected therein by one skilled in the art without departing from the scope or spirit of the invention as defined in the appended claims.

What is claimed is:

1. A method of using a computer system as a telemicroscope, comprising:
 - (a) capturing a first image corresponding to an area of a specimen with a digital image capturing device;
 - (b) capturing at least one second image corresponding to a selected area of the first image, said second image having a different magnification from the first image;
 - (c) storing the first and second images in a computer-readable medium; and
 - (d) generating a linking information map indicating the relationship between said first and second images.
2. The method of claim 1, wherein said capturing of second image is performed a plurality of times on different selected areas of the specimen, wherein the linking information map links the first image to each of the plurality of second images.
3. The method of claim 2, further comprising choosing a desired area of the first image for obtaining a corresponding magnified second image thereof after said generating of the linking information map.
4. The method of claim 3, wherein the linking information map facilitates the viewing of a desired area of the specimen by providing the appropriate second image linked to said desired area of the first image.
5. The method of claim 4, wherein said first and second images are stored in a similar format, wherein said format is one of JPG, GIF, TIF or BMP.
6. The method of claim 4, wherein said first image is stored in a format chosen from a group consisting of JPG, GIF, TIF and BMP.

7. The method of claim 4, wherein said second image is stored in a format chosen from a group consisting of JPG, GIF, TIF and BMP.
8. The method of claim 5, further comprising storing of the information map in said computer-readable medium.
9. The method of claim 8, wherein said computer-readable medium is one of computer hard drive, portable disk or CD.
10. The method of claim 8, wherein said computer-readable medium is a web server.
11. The method of claim 8, wherein the digital image capturing device is a digital camera.
12. The method of claim 8, wherein the digital image capturing device is a scanner.
13. A method of using a computer system as a telemicroscope, comprising:
 - (a) capturing a plurality of images corresponding to different segments of a specimen with a digital image capturing device, said images having different magnification levels;
 - (b) generating a linking information map for said images of the specimen indicating relationships between said images of the different segments of the specimen; and
 - (c) storing said images and linking information map in a computer-readable medium, wherein the information map allows a user to view said specimen under different magnification levels.
14. The method of claim 13, wherein the linking information map facilitates viewing of a desired segment of the specimen by providing the appropriate image corresponding to the desired magnification level of said desired segment of said image.

15. The method of claim 14, further including posting the images and the information map to a network for allowing a remote user to access said images and said information map after said storing.
16. The method of claim 14, further including sending the images and the information map to a remote user via an e-mail for allowing the remote user to access said images and said linking information map after said storing.
17. The method of claim 14, wherein said images are stored in a similar format, wherein said format is one of JPG, GIF, TIF or BMP.
18. The method of claim 14, wherein the digital image capturing device is a digital camera.
19. The method of claim 14, wherein the digital image capturing device is a scanner.
20. A method of using a computer system as a telemicroscope comprising:
- (a) storing a captured first image of a specimen electronically, wherein the first image includes the entire specimen, said first image captured with a digital image capturing device;
 - (b) storing a captured second image of the specimen electronically, wherein the second image includes a smaller area of the specimen and has a higher magnification level than said first image, said second image captured with a digital image capturing device; and
 - (c) generating an information map for linking said first image with said second image, wherein said information map allows a user to view a magnification of a selected area of said first image by uploading the appropriate second image that corresponds to said selected area.

21. The method of claim 20, further including sending the images and the information map to a remote user via an e-mail for allowing the remote user to access said images and said information map after said storing.
22. The method of claim 20, wherein said first image and said second image are each stored in a similar format, wherein said format is one of JPG, GIF, TIF or BMP.
23. The method of claim 22, where said first image and said second image are stored on a computer-readable medium.
24. The method of claim 20, further including, compiling the information map, after said storing of said captured second image.
25. The method of claim 24, wherein the information map is stored on a computer-readable medium.
26. A method of using a computer system as a telemicroscope comprising:
- (a) receiving from a user a location for an index file, said index file stored on a computer-readable medium;
 - (b) retrieving said index file, said index file listing a plurality of image files, wherein each of said image file has an image of a specimen and map information of linked images;
 - (c) displaying on the monitor screen of the user's computer system the listing of the plurality of image files from the index file;
 - (d) receiving from the user a first file name comprising an image of the entire specimen, wherein the first file name is linked to a second file name comprising an image of a selected area of the specimen, wherein said image of said second file name has a different magnification level from the image in said first file name; and

(e) displaying dynamically the images of said first and second file name allowing a user to view the specimen with different magnification levels of the specimen.

27. The method of claim 26, wherein the location of said index file is selected from a group consisting of an Internet URL, a path of an intranet, and a local file.

28. The method of claim 26, wherein said displaying includes providing a tool bar on the monitor screen of the computer system for allowing a user to select different viewing and navigation options.

29. The method of claim 28, wherein said tool bar provides a magnifying means to view the specimen.

30. The method of claim 29, wherein said magnifying means magnifies the specimen between 1.5 and 5 times from the displayed image on the screen without losing resolution.

31. The method of claim 29, wherein said magnifying means comprises a movable virtual lens for allowing the user to adjust the magnification level and select the section of the specimen being magnified thereby dynamically displaying the magnified portion of the image on the entire screen. .

32. The method of claim 31, wherein the movable virtual lens is a viewing window on a monitor of said computer system.

33. The method of claim 29, wherein said magnifying means is a virtual microscope with a virtual slide that allows a user to view the specimen, wherein said virtual microscope is provided with a virtual objective lens which is situated on top of said virtual slide thereby allowing the encased area within the virtual objective lens to be enlarged onto the entire monitor screen dynamically and allowing the user to adjust the magnification level.

34. The method of claim 33, wherein said virtual objective lens is movable on a monitor screen of said computer system to allow said objective lens to move around on said virtual slide thereby dynamically displaying the enlarged portion of the image on the entire screen.
35. The method of claim 33, the magnification capacity of said virtual objective lens is up to 200 from the original size of said specimen.
36. The method of claim 26, further comprising receiving a communication request from a user to discuss the specimen with another user, said communication request received via a communication means.
37. The method of claim 36, wherein said communication means is selected from a group consisting of e-mail, video conferencing, whiteboard image sharing, chat room, and Internet telephony.
38. A method of using a computer system as a telemicroscope comprising:
- (a) capturing a plurality of images of a specimen, wherein the images correspond to an entire specimen and a plurality of segments of said specimen, wherein images corresponding to said plurality of segments have different magnification levels;
 - (b) generating a linking map between said images wherein said linking map comprises information regarding geographical location of the images in relation to the specimen's structure; and
 - (c) transmitting said images and said linking map to a remote user via a computer network thereby allowing the user to view the images with different magnification levels.

39. The method of claim 38, wherein said plurality of images are captured with a digital image capturing device.
40. The method of claim 39, further including storing said images and said linking map on an electronic medium.
41. The method of claim 40, wherein said transmitting comprises encrypting said images and said linking map.
42. The method of claim 41, wherein the computer network is selected from a group consisting of an Internet, intranet, and a local area network.
43. A system for using a computer system as a telemicroscope, comprising:
- (a) a memory unit;
 - (b) a processing unit in communication with said memory unit, wherein said processing unit is configured to:
 - i. capture a first image corresponding to an area of a specimen;
 - ii. capture at least one second image corresponding to a selected area of said first image, said second image having a different magnification from the first image;
 - iii. store the first and second images in a computer-readable medium; and
 - iv. generate a linking information map indicating the relationship between said first and second images.
44. The system of claim 43, further comprising a digital image capturing device for capturing said first image and second image, said digital image capturing device in communication with said processor unit.

45. The system of claim 44, wherein said digital image capturing device is a digital camera.

46. The system of claim 44, wherein said digital image capturing device is a scanner.

47. A system for using a computer system as a telemicroscope, comprising:

(a) a memory unit;

(b) a processing unit in communication with said memory unit, wherein said

processing unit is configured to:

i. receive a location for an index file, said index file stored on said memory

unit;

ii. retrieve said index file, said index file listing a plurality of image files,

wherein each of said image file has an image of a specimen;

iii. display the listing of the plurality of image files from the index file;

iv. receive a first file comprising an entire background image of the

specimen;

v. receive a first file comprising an image of a portion of the specimen,

wherein said image in said second file has a different magnification level from the image in said first file; and

vi. display the image of said first file and the image of said second file for

allowing a user to view the specimen with different magnification levels of the specimen.

48. A system for using a computer system as a telemicroscope, comprising:

(c) a memory unit;

(d) a processing unit in communication with said memory unit, wherein said

processing unit is configured to:

- i. capture a plurality of images of a specimen, wherein the images correspond to the entire specimen and a plurality of segments of said specimen, wherein images corresponding to said plurality of segments have different magnification levels;
- ii. generate a linking map between said images wherein said linking map comprises information regarding geographical location of the images in relation to the specimen's structure; and
- iii. transmit said images and said linking map to a remote user via a computer network thereby allowing the user to view the images with different magnification levels.

49. A system for using a computer system as a telemicroscope, comprising:

- (a) means for capturing a first image corresponding to an area of a specimen with a digital image capturing device;
 - (b) means for capturing at least one second image corresponding to a selected area of the first image, said second image having a different magnification from the first image;
 - (c) means for storing the first and second images in a computer-readable medium;
- and
- (d) means for generating a linking information map indicating the relationship between said first and second images.

50. A system for using a computer system as a telemicroscope, comprising:

- (a) means for receiving a location for an index file, said index file stored on a computer-readable medium;
- (b) means for retrieving said index file, said index file listing a plurality of image files, wherein each of said image file has an image of a specimen;

(c) means for displaying the listing of the plurality of image files from the index file;

(d) means for receiving a first file comprising an image of the entire specimen,

wherein the first file is linked to a second file comprising an image of a portion of the specimen, wherein said the image in said second file has a different magnification level from the image in said first file; and

(e) means for displaying the image of said first file and the image of said second file for allowing a user to view the specimen with different magnification levels of the specimen.

51. A system for using a computer system as a telemicroscope, comprising:

(a) means for capturing a plurality of images of a specimen, wherein the images correspond to the entire specimen and a plurality of segments of said specimen, wherein images corresponding to said plurality of segments have different magnification levels;

(b) means for generating a linking map between said images wherein said linking map comprises information regarding geographical location of the images in relation to the specimen's structure; and

(c) means for transmitting said images and said linking map to a remote user via a computer network thereby allowing the user to view the images with different magnification levels.

52. A computer-readable medium comprising:

(a) instruction code for capturing a first image corresponding to an area of a specimen with a digital image capturing device;

(b) instruction code for capturing at least one second image corresponding to a selected area of the first image, said second image having a different magnification from the first image;

(c) instruction code for storing the first and second images in a computer-readable medium; and

(d) instruction code for generating a linking information map indicating the relationship between said first and second images.

53. A computer-readable medium comprising:

(a) instruction code for receiving a location for an index file, said index file stored on a computer-readable medium;

(b) instruction code for retrieving said index file, said index file listing a plurality of image files, wherein each of said image file has an image of a specimen;

(c) instruction code for displaying the listing of the plurality of image files from the index file;

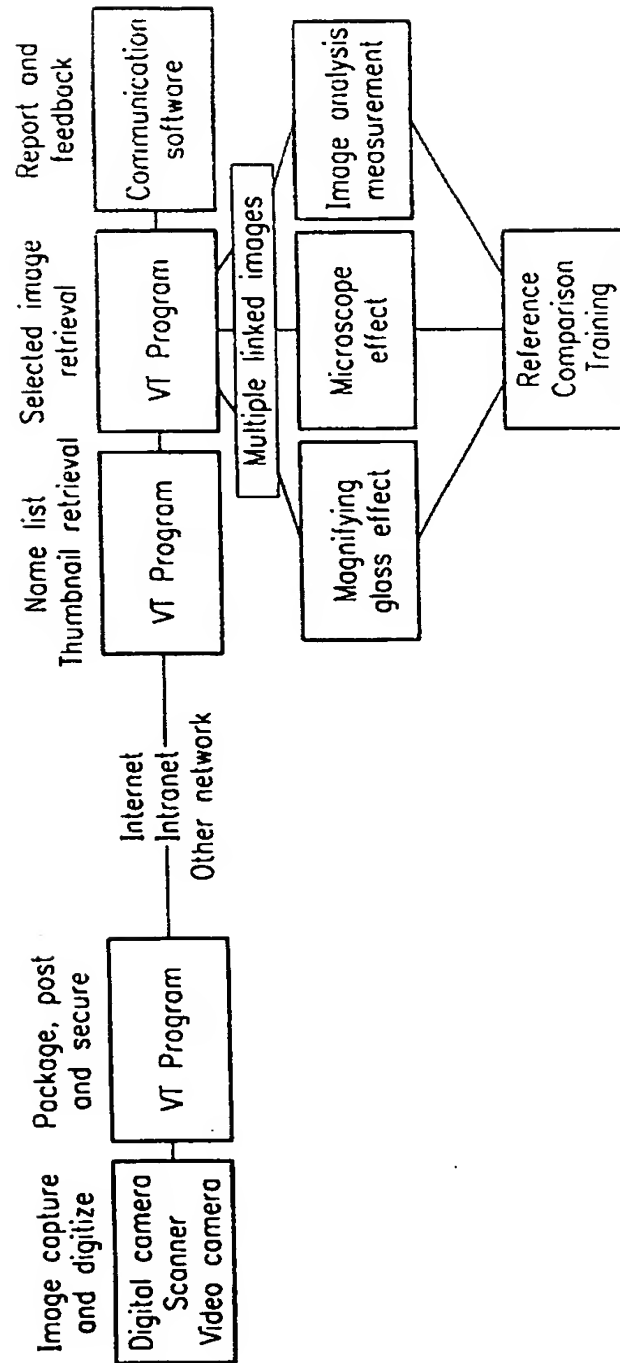
(d) instruction code for receiving a first file comprising an image of the entire specimen, wherein the first file is linked to a second file comprising an image of a portion of the specimen, wherein said the image in said second file has a different magnification level from the image in said first file; and

(e) instruction code for displaying the image of said first file and the image of said second file for allowing a user to view the specimen with different magnification levels of the specimen.

54. The method of claim 28, wherein said tool bar provides a measurement function thereby enabling the user to directly measure the images on the monitor screen.
55. The method of claim 54, wherein the measurement function enables a user to calibrate a measuring unit by referring to a known distance of the specimen thereby ensuring an accurate reading of distances on the monitor screen at any magnifications of the original image.
56. The method of claim 54, wherein said tool bar provides an image database linkage thereby enabling the user to compare the images instantly by retrieving the images from said database.
57. The method of claim 55, wherein said database is located remotely from the user's computer and connected to the user's computer through a computer network.
58. The method of claim 54, wherein said tool bar provides a text data association function thereby allowing the user to associate the text data to the images for a future reference.

1 / 21

Principle of the Virtual Telemicroscope System



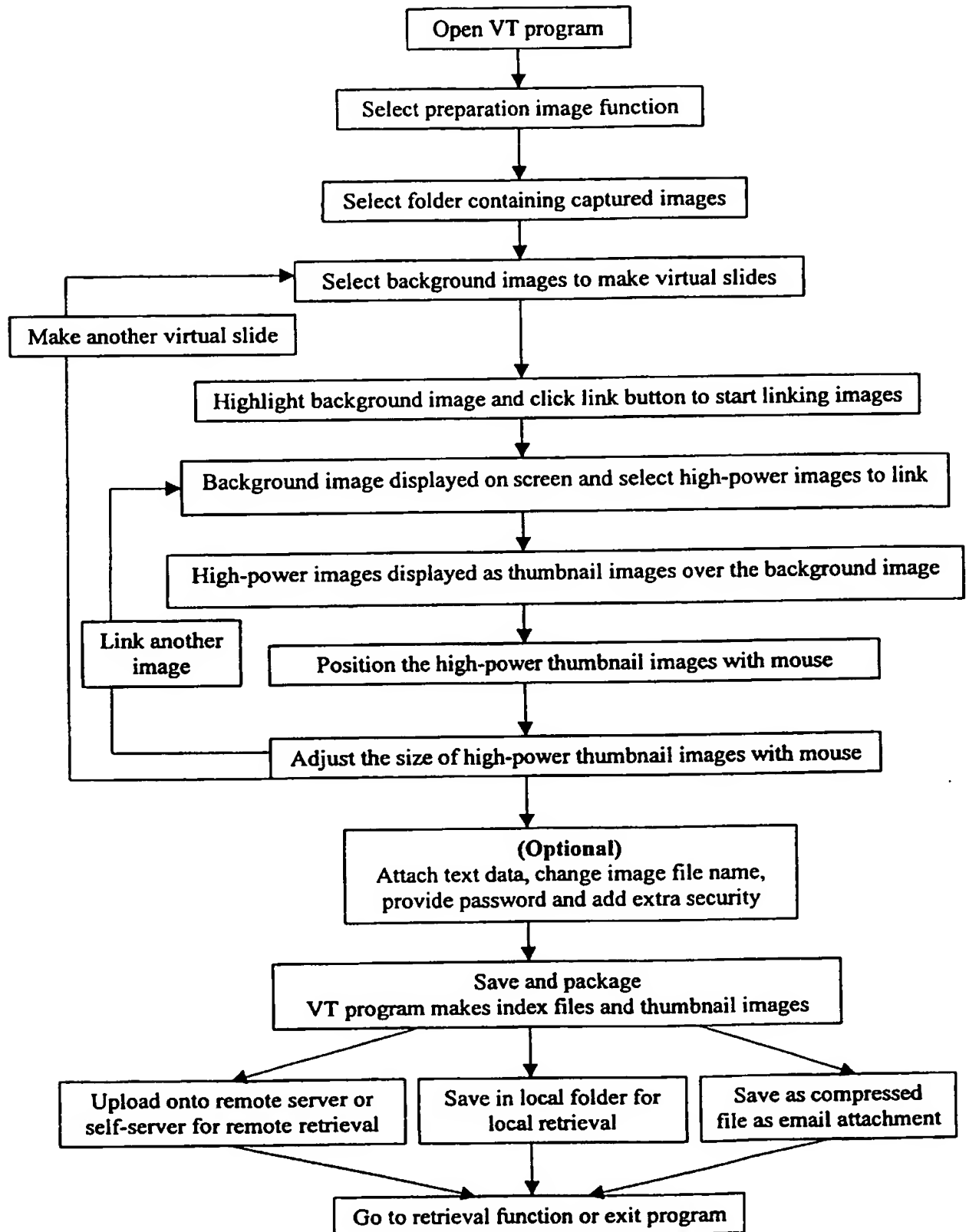
Computer station one

Computer station two

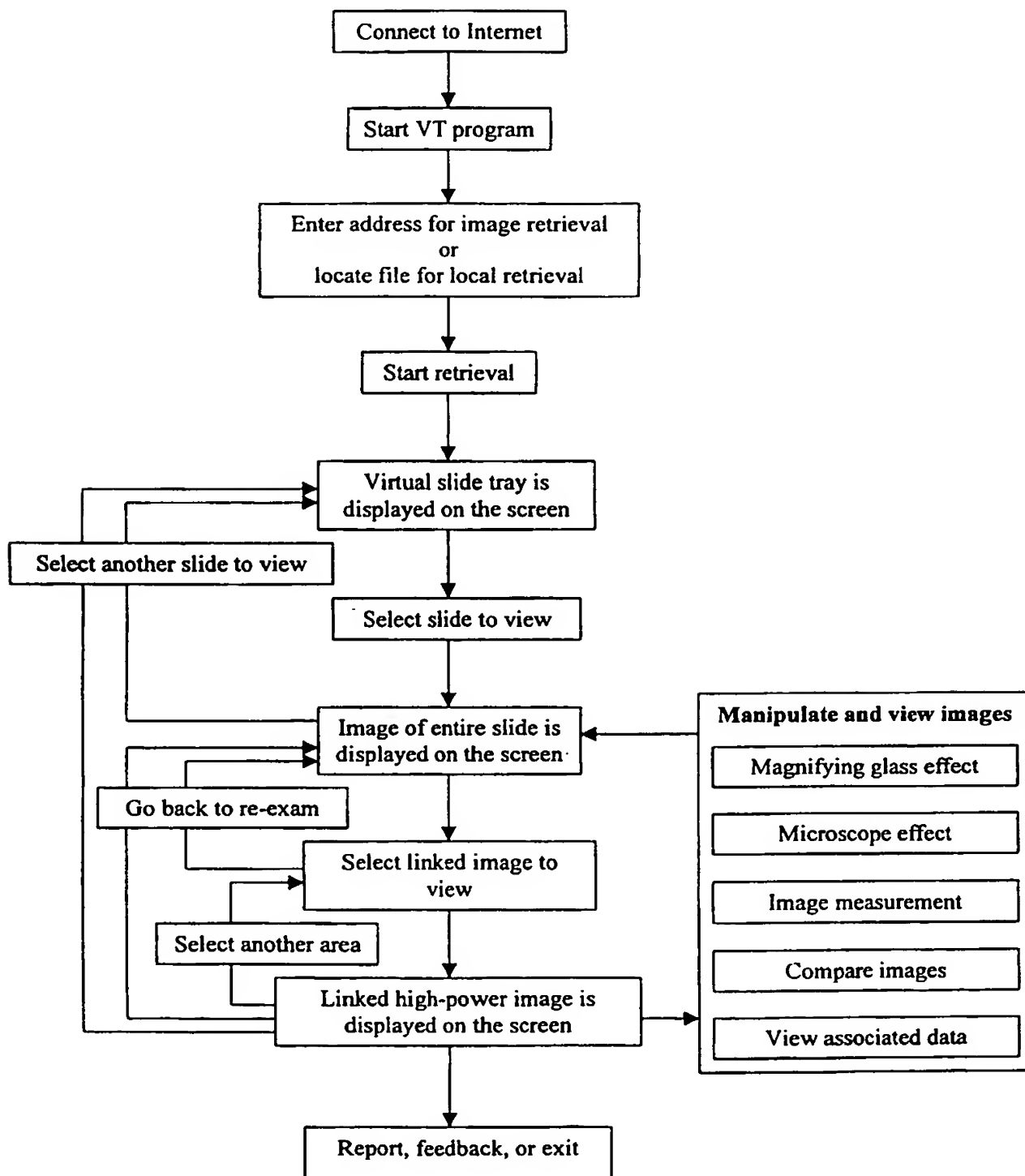
Note: Functions of the two computers can be reversed. Both can send and receive images.

FIG. 1

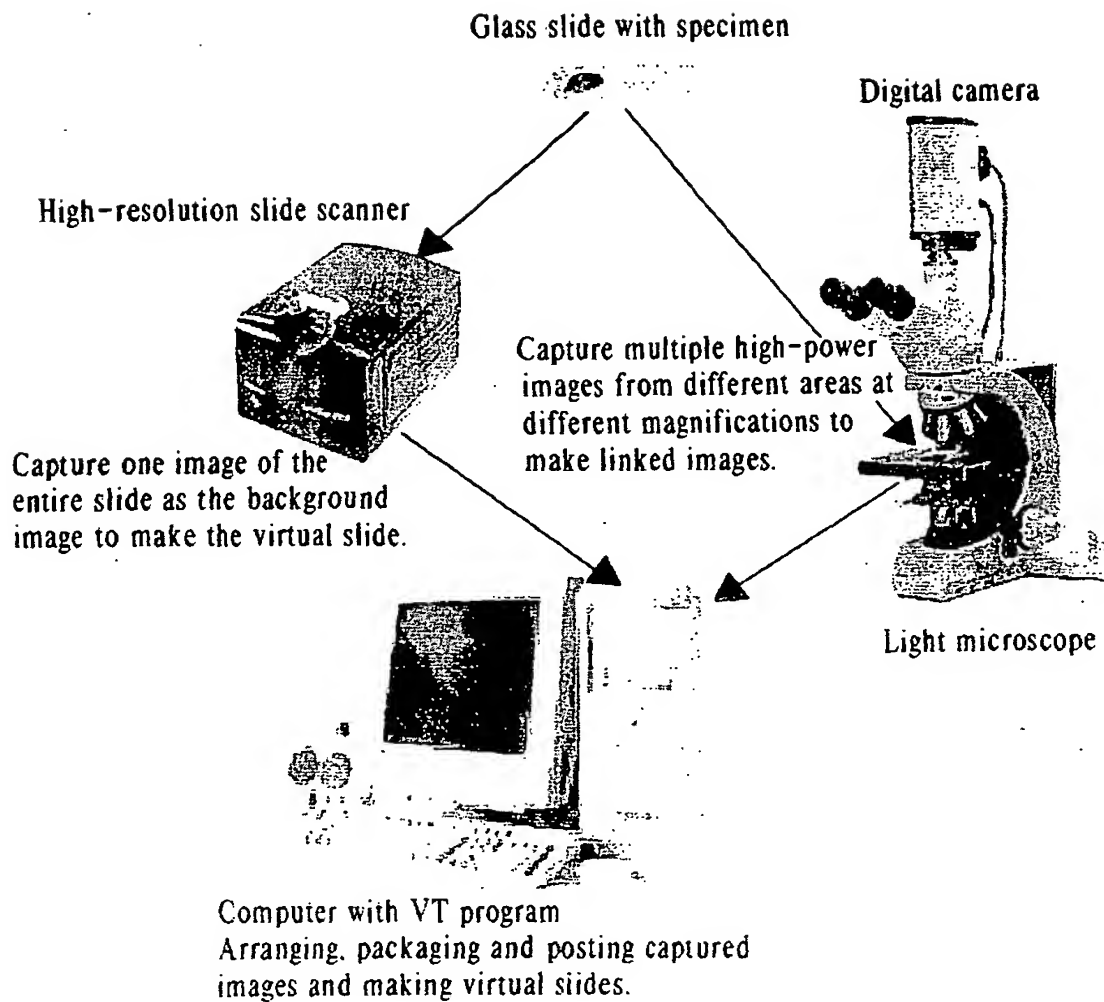
2 / 21

Image arrangement, packaging and posting**FIG. 2a**

3/21

Retrieve and view images**FIG. 2b**

4 / 21



Hardware setup of the VT system

FIG. 3

5/21

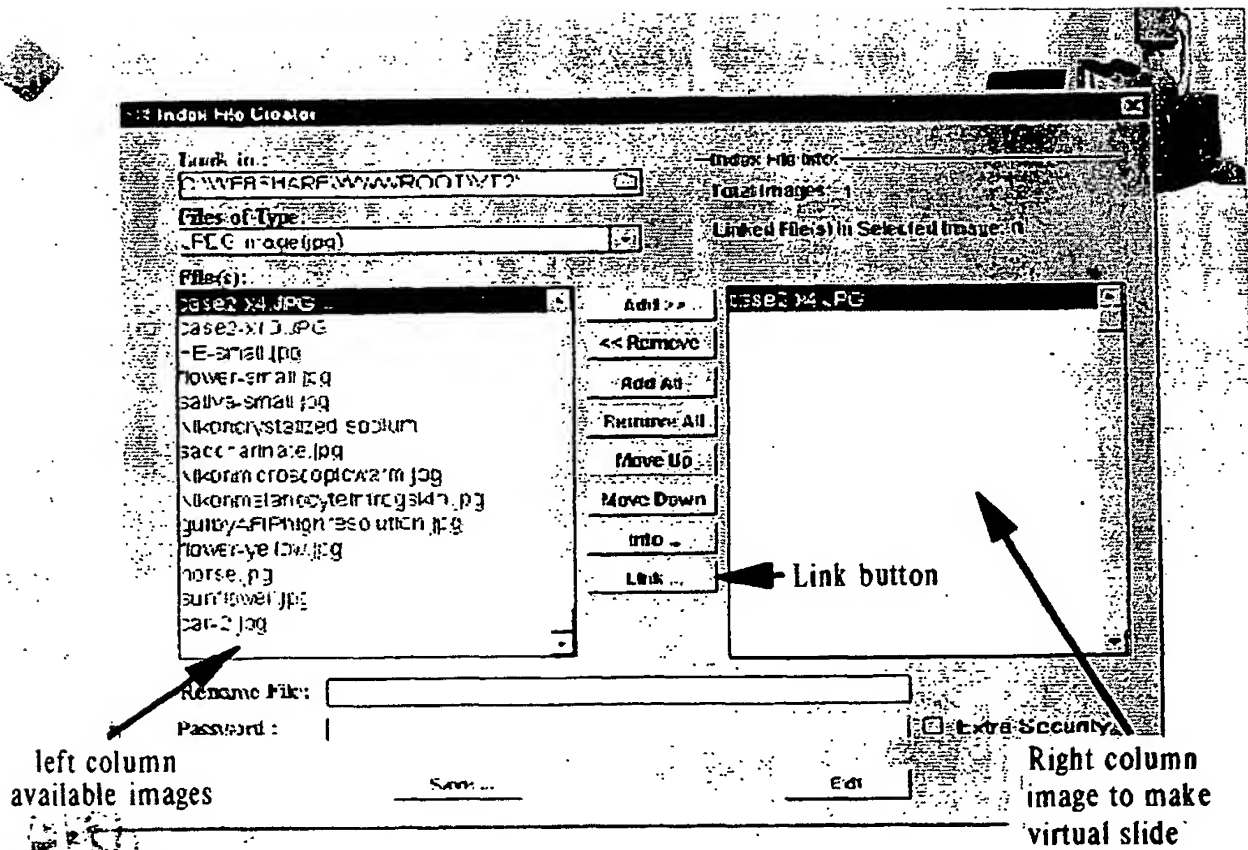


FIG. 4a

6 / 21

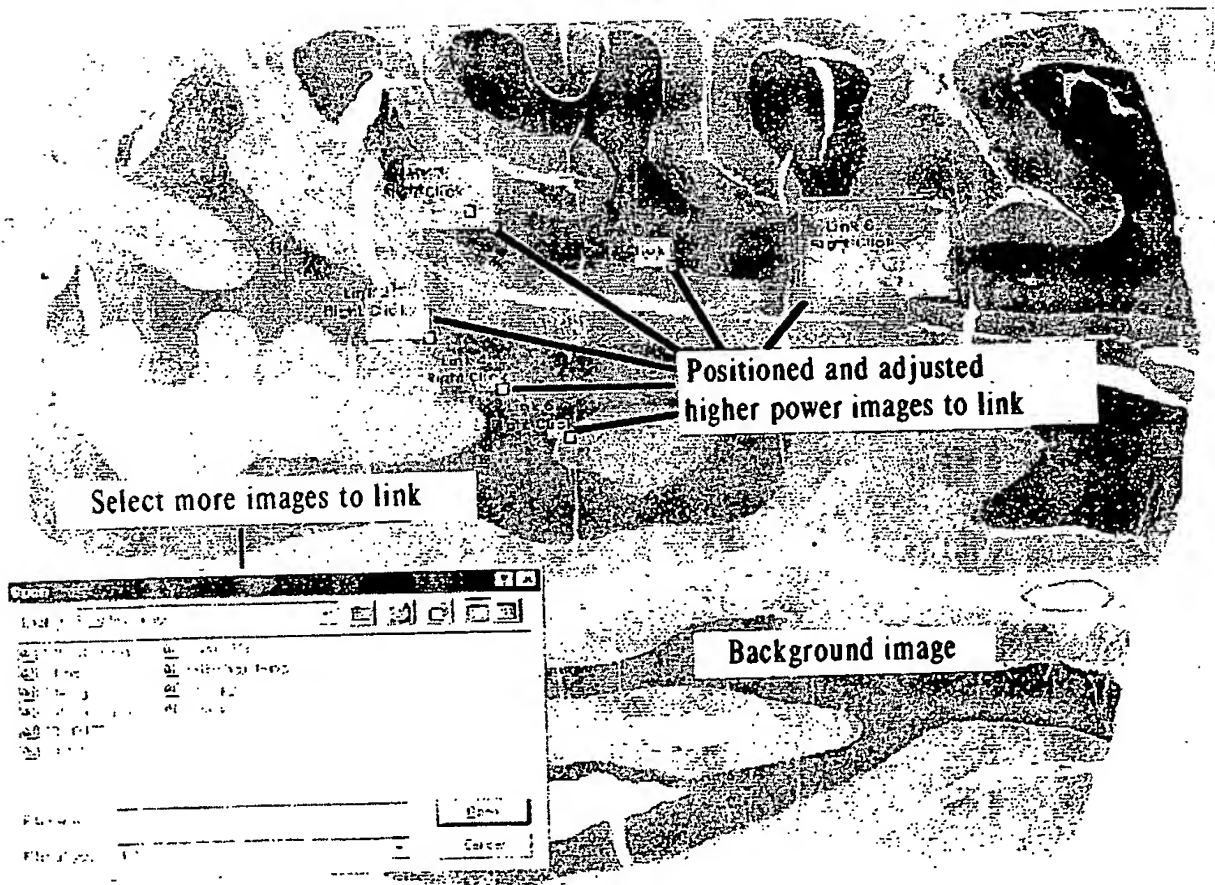


FIG. 4b

7/21

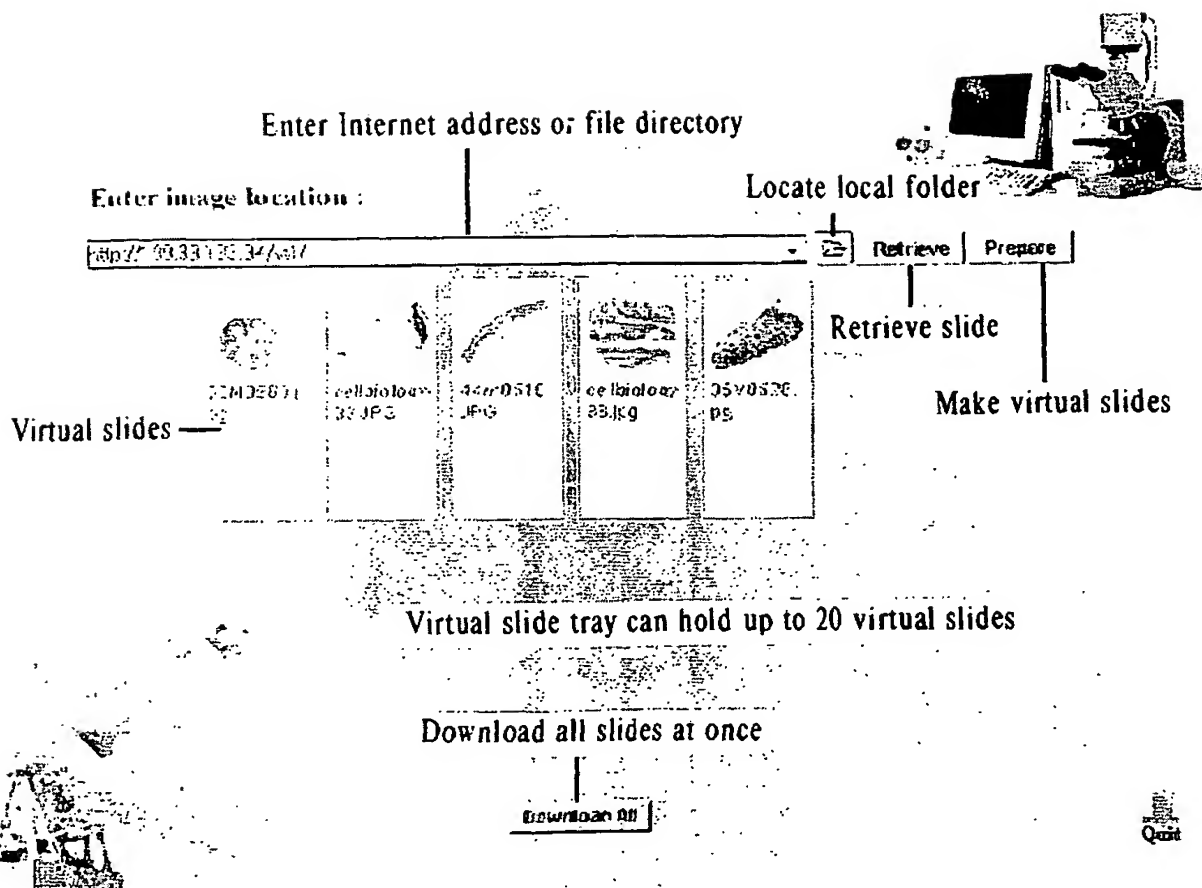


FIG. 5

8/21

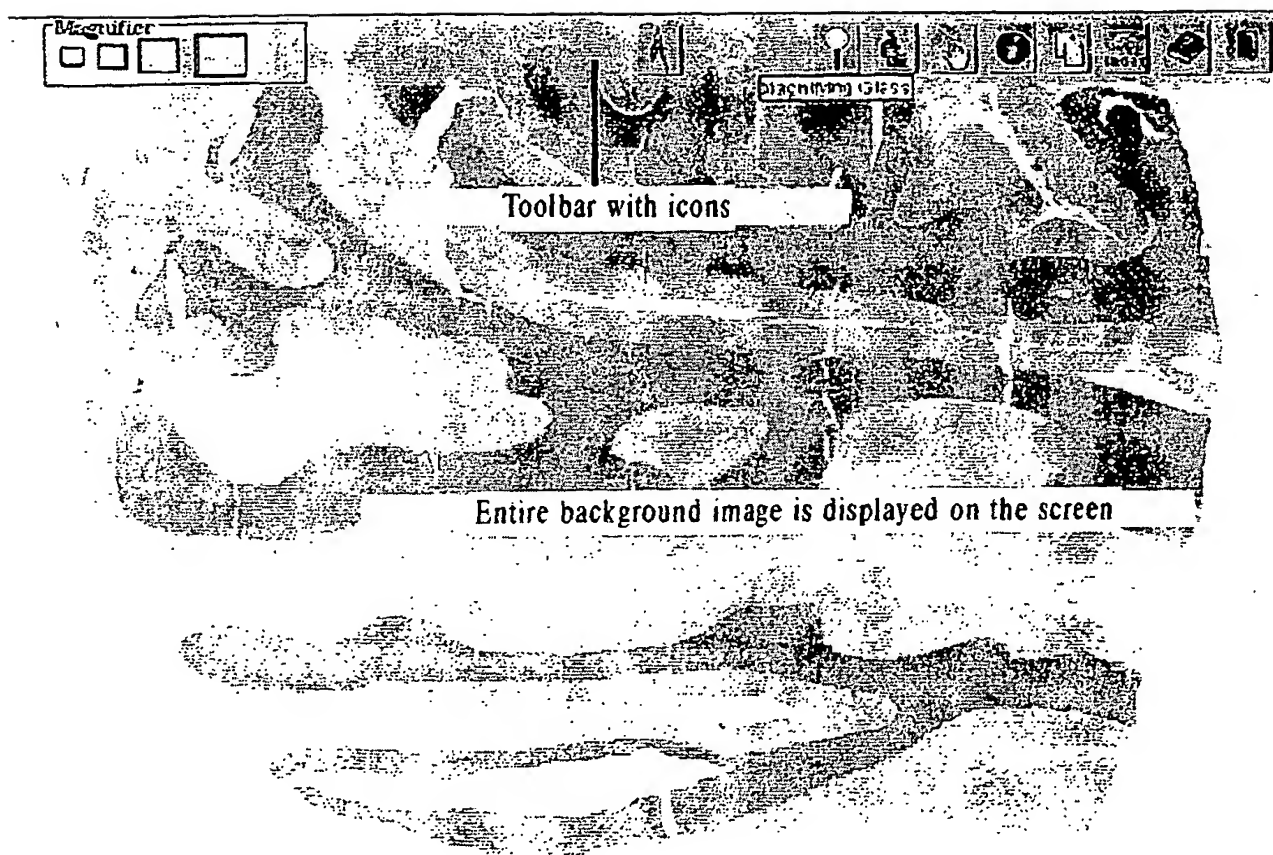


FIG. 6

9/ 21

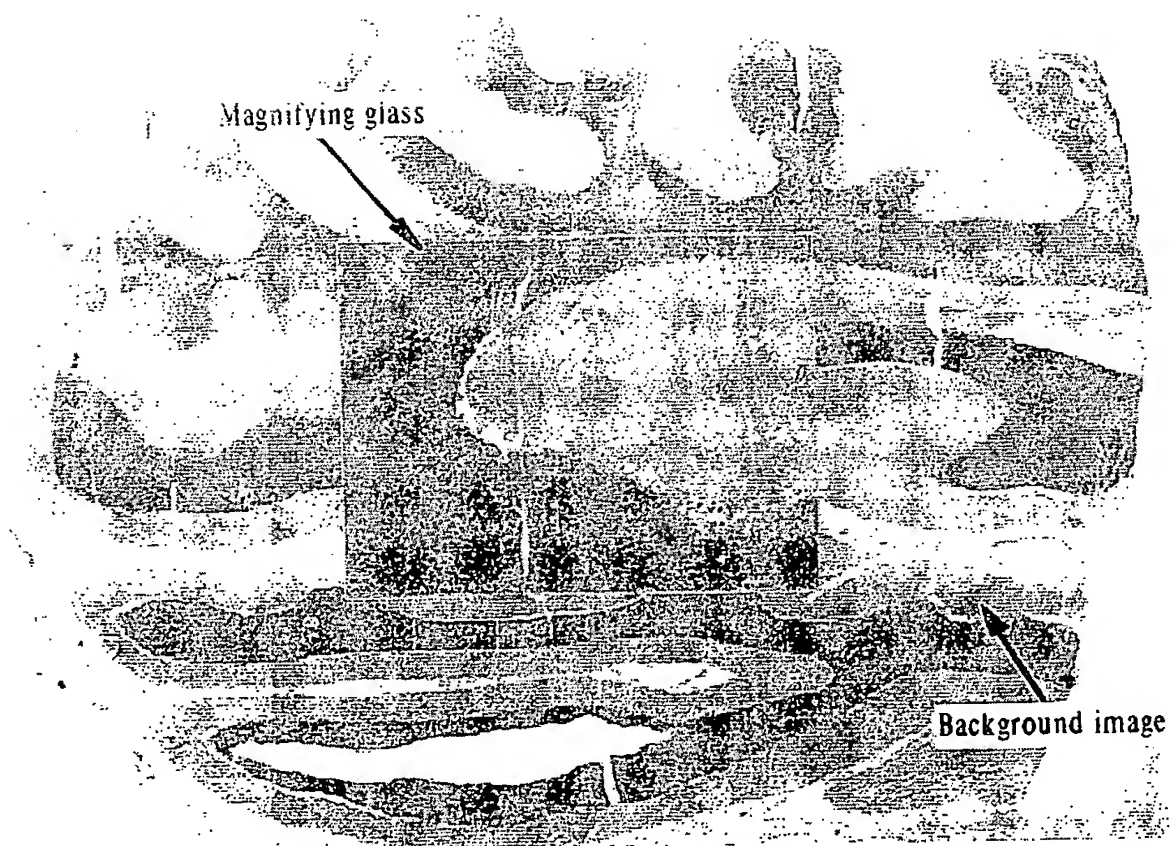


FIG. 7

10/21

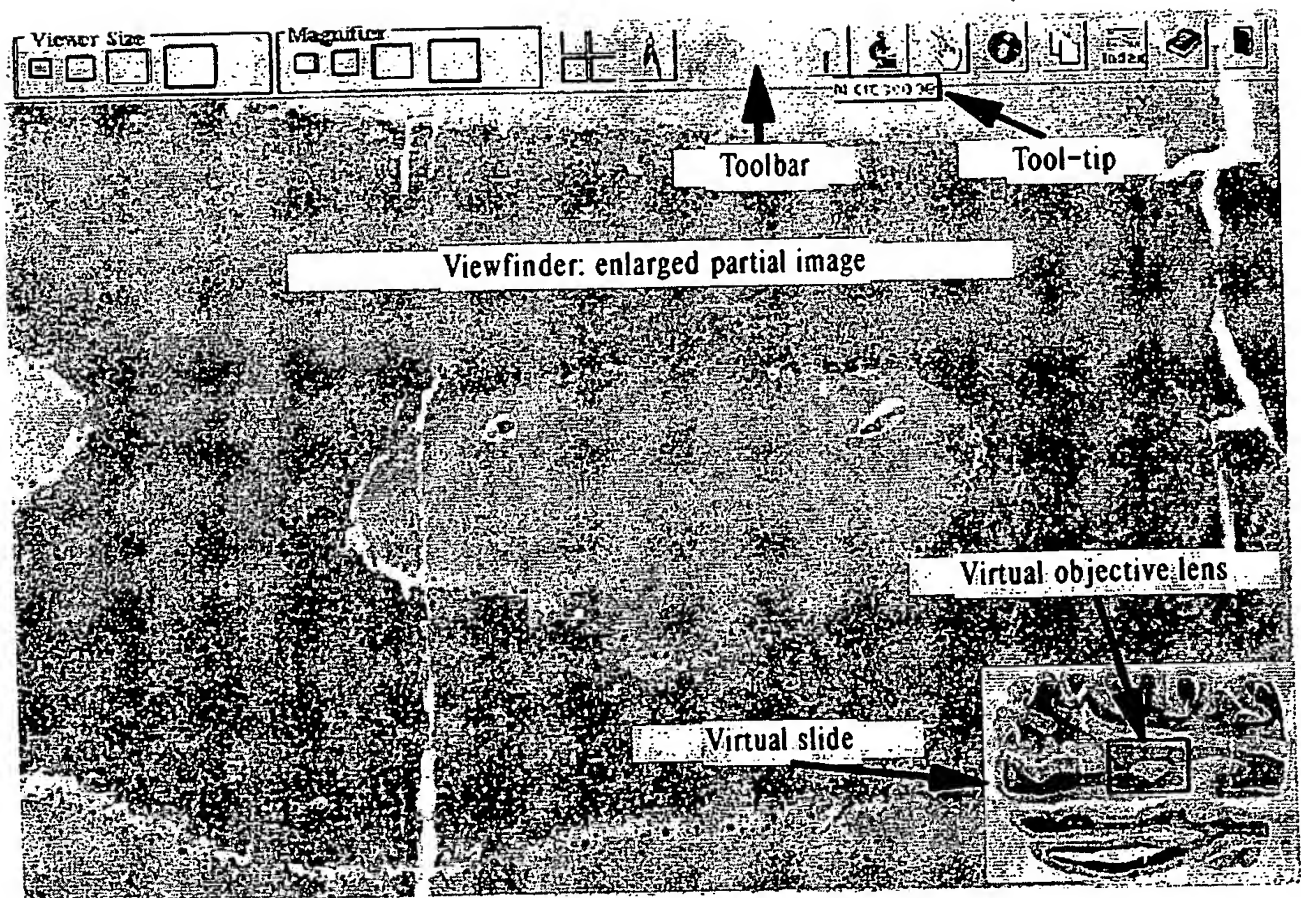


FIG. 8

11/21

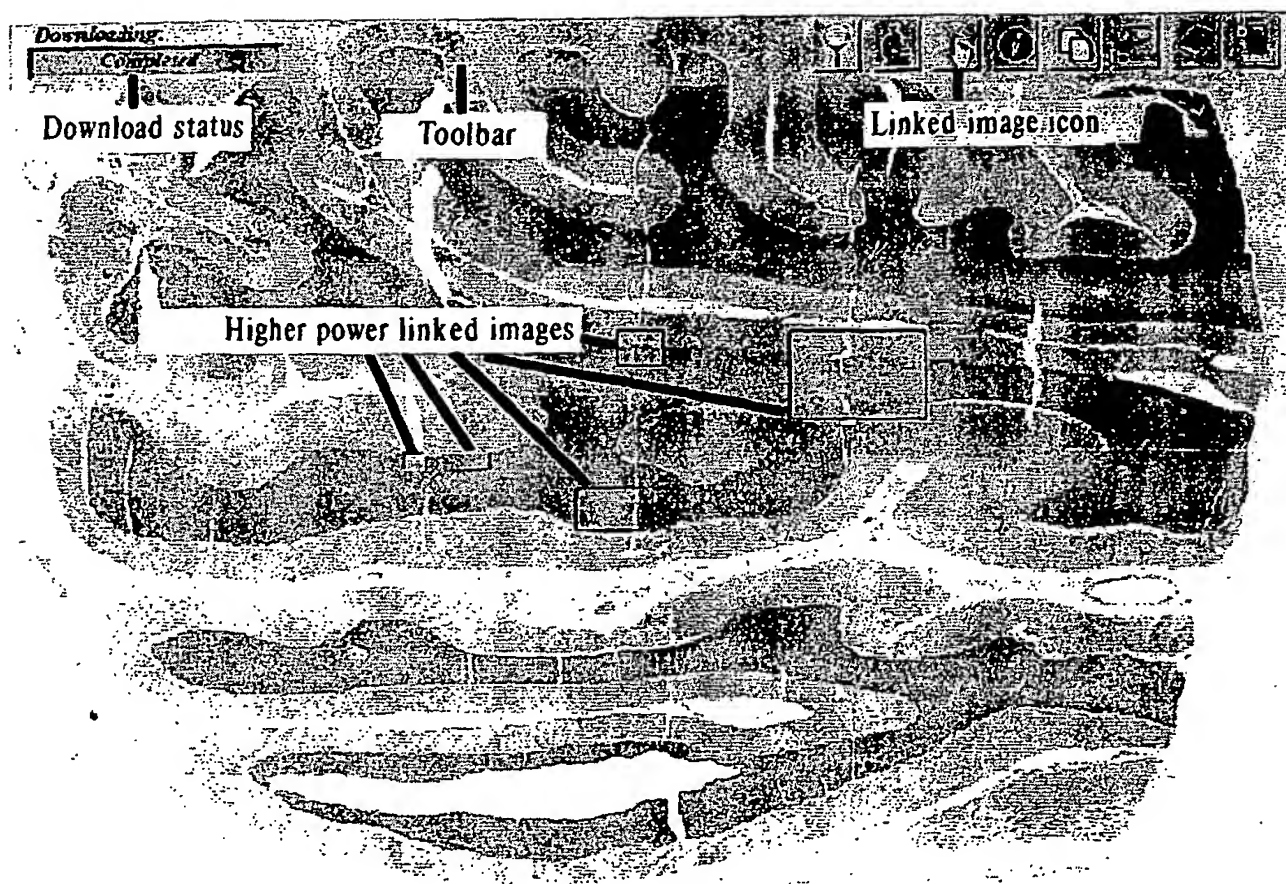


FIG. 9

12 / 21

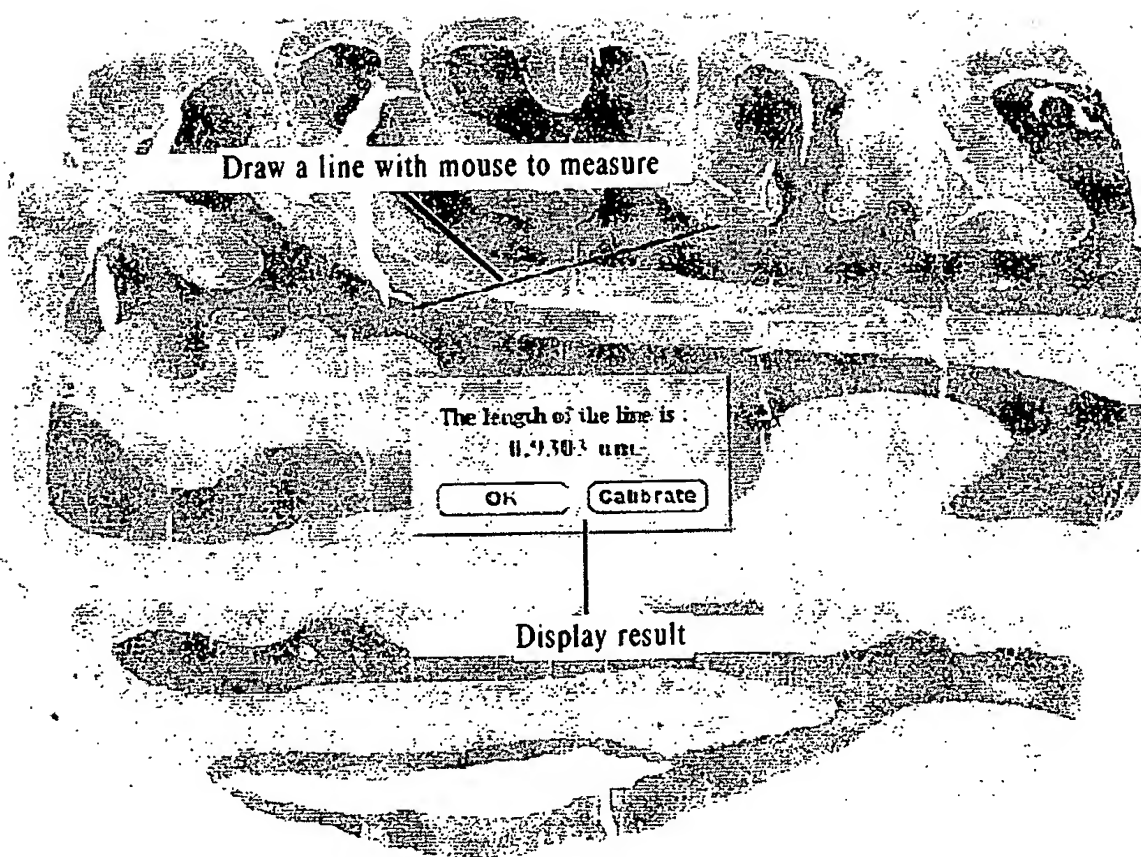


FIG. 10

13/21

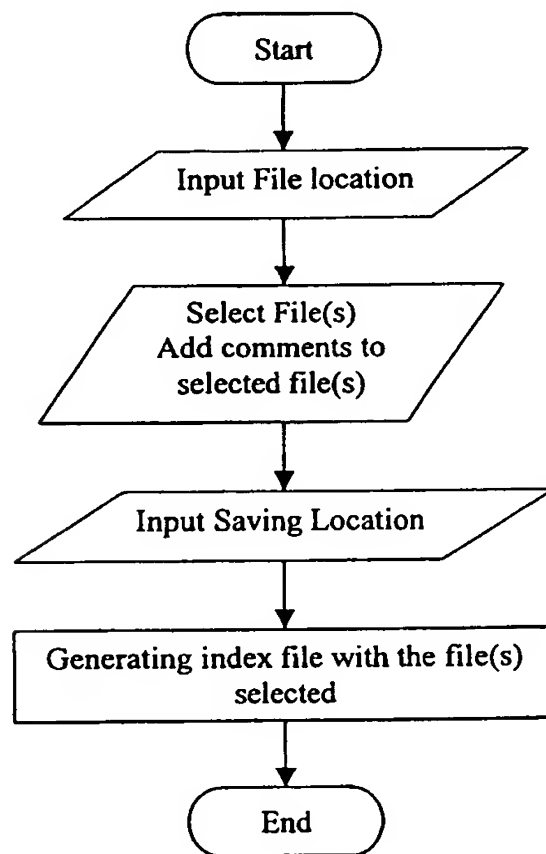
VT Program Package, Posting and Security Flowchart:

FIG. 11a

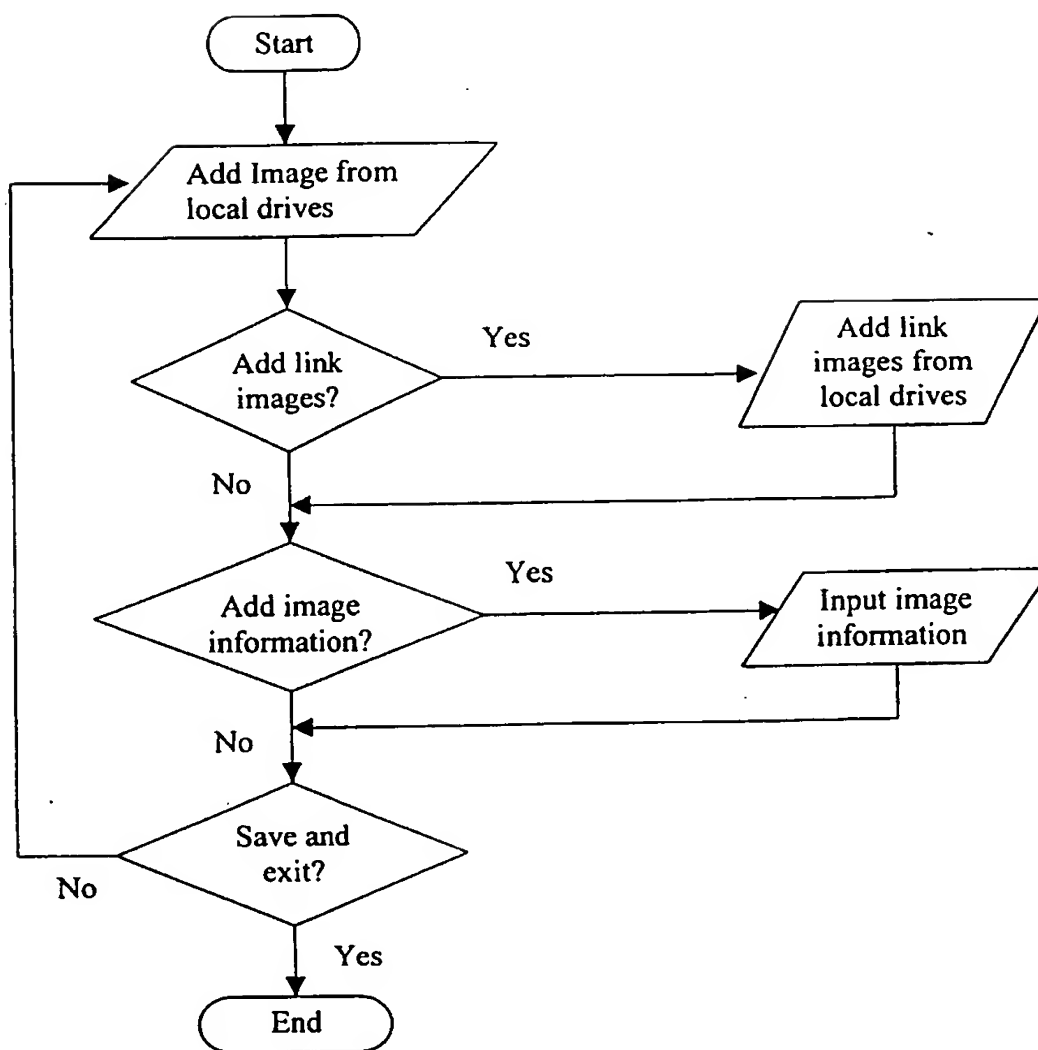
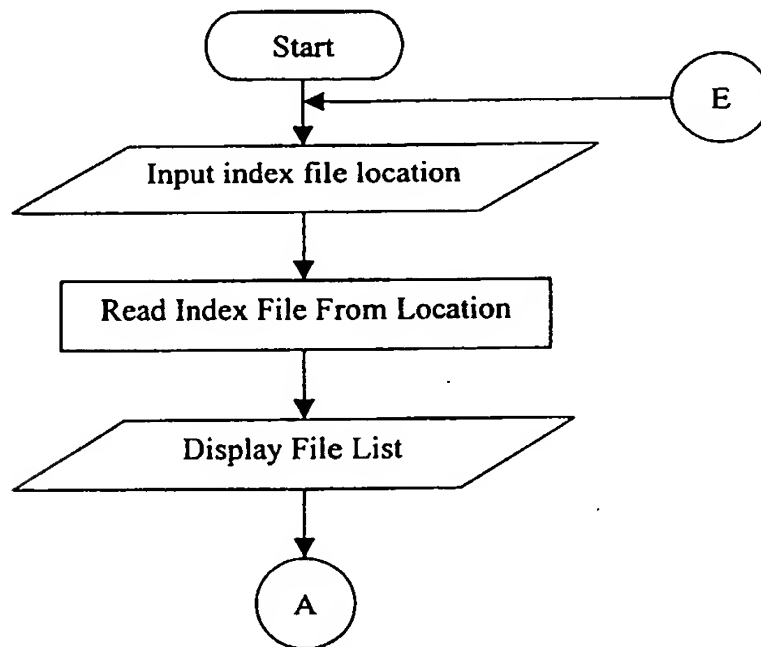
Index File Creator Flow Chart:

FIG. 11b

VT Program Name List and Thumbnail Image Retrieval Flowchart:**FIG. 11c**

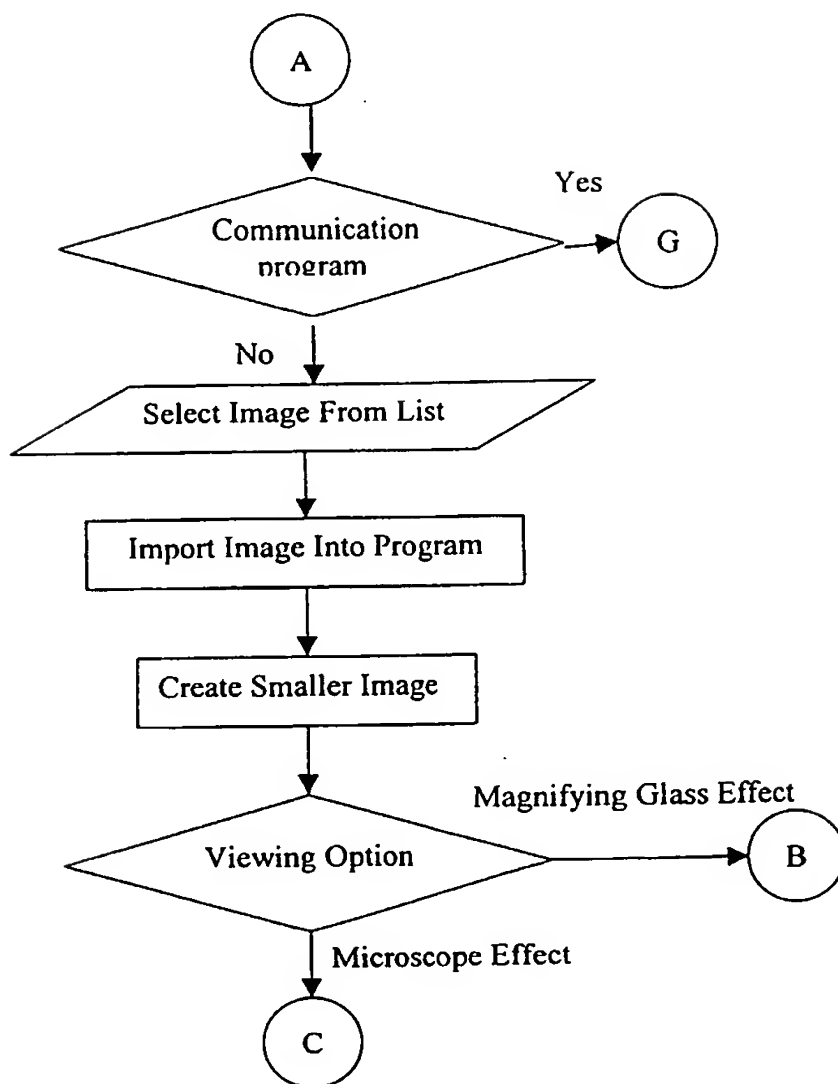
Selected Image Retrieval Flowchart:

FIG. 11d

17/21

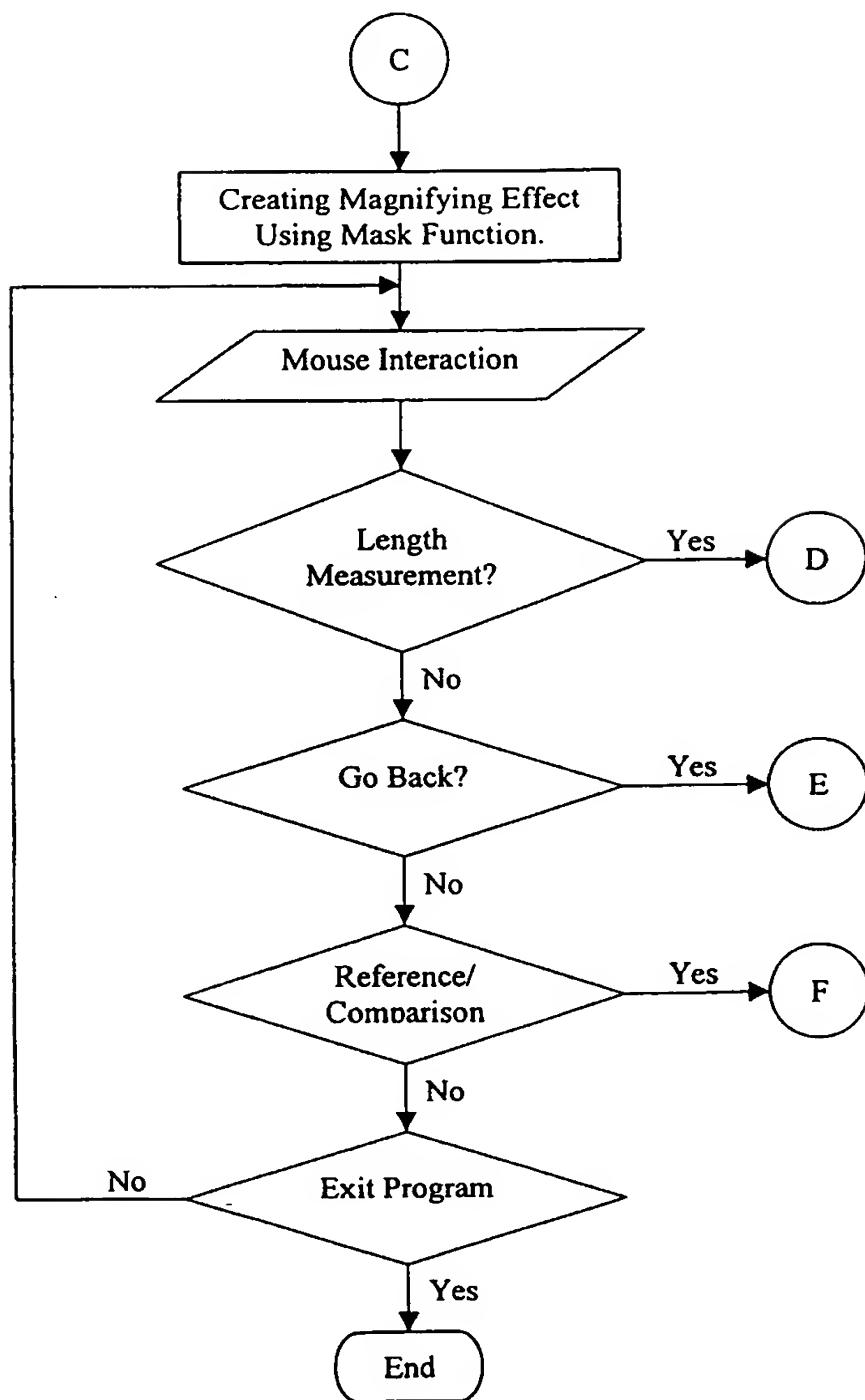
Magnifying Glass Effect Flowchart:

FIG. 11e

18/ 21

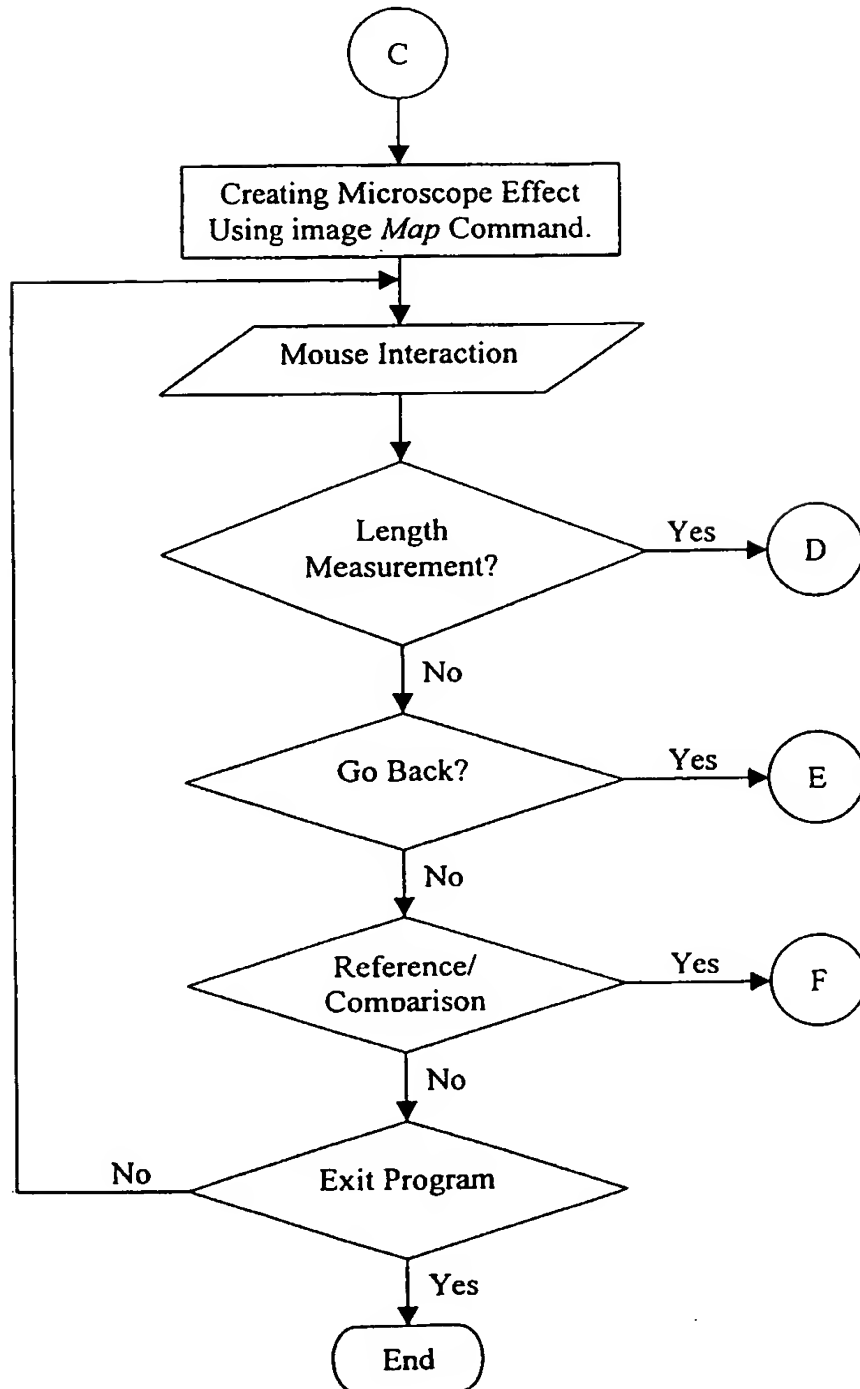
Microscope Effect Flowchart:

FIG. 11f

19/21

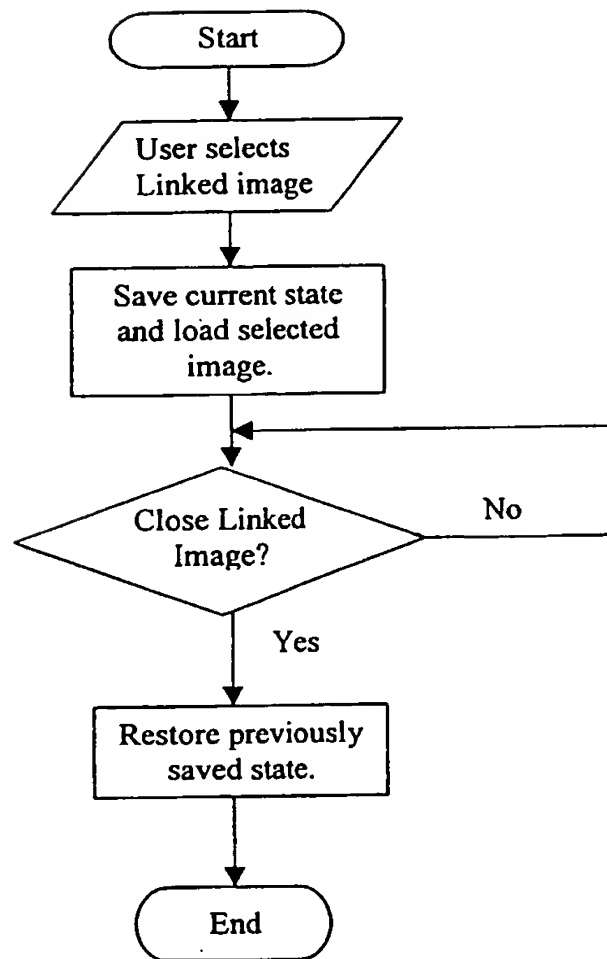
Go to Linked Image Flow Chart:

FIG. 11g

20/21

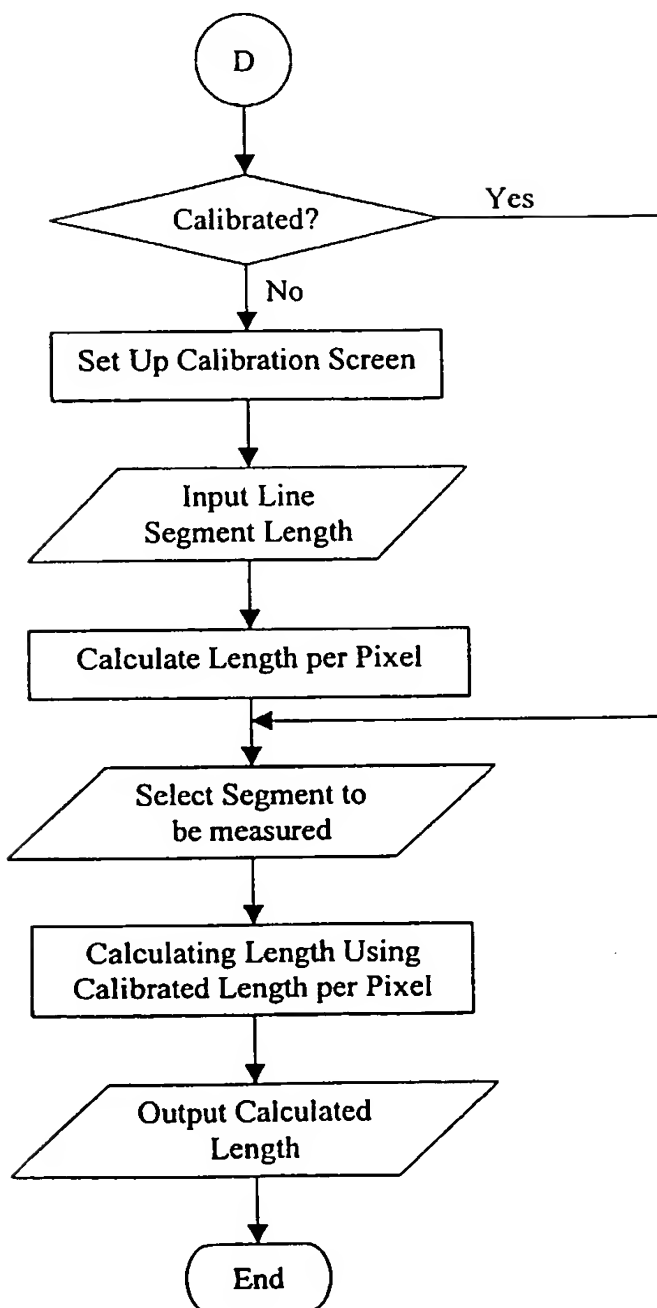
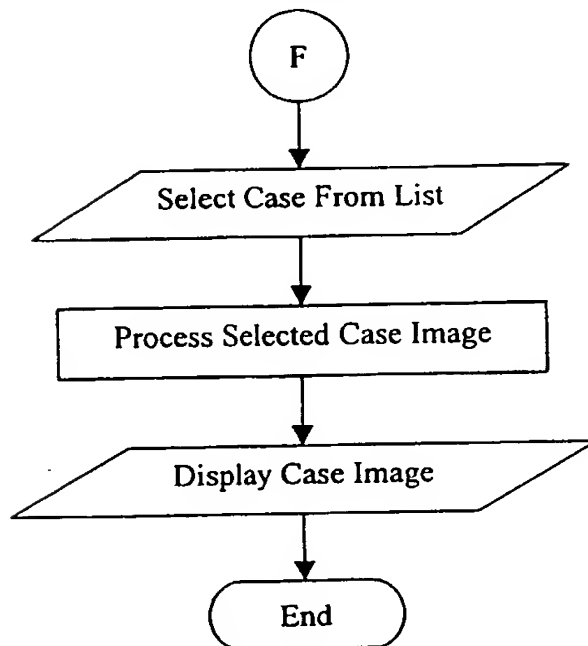
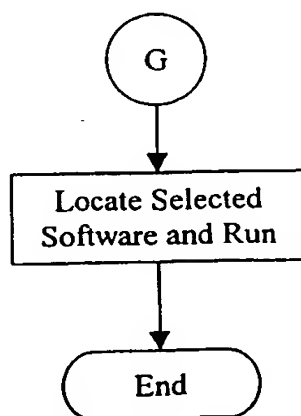
Length Measurement Flowchart:

FIG. 11h

21 / 21

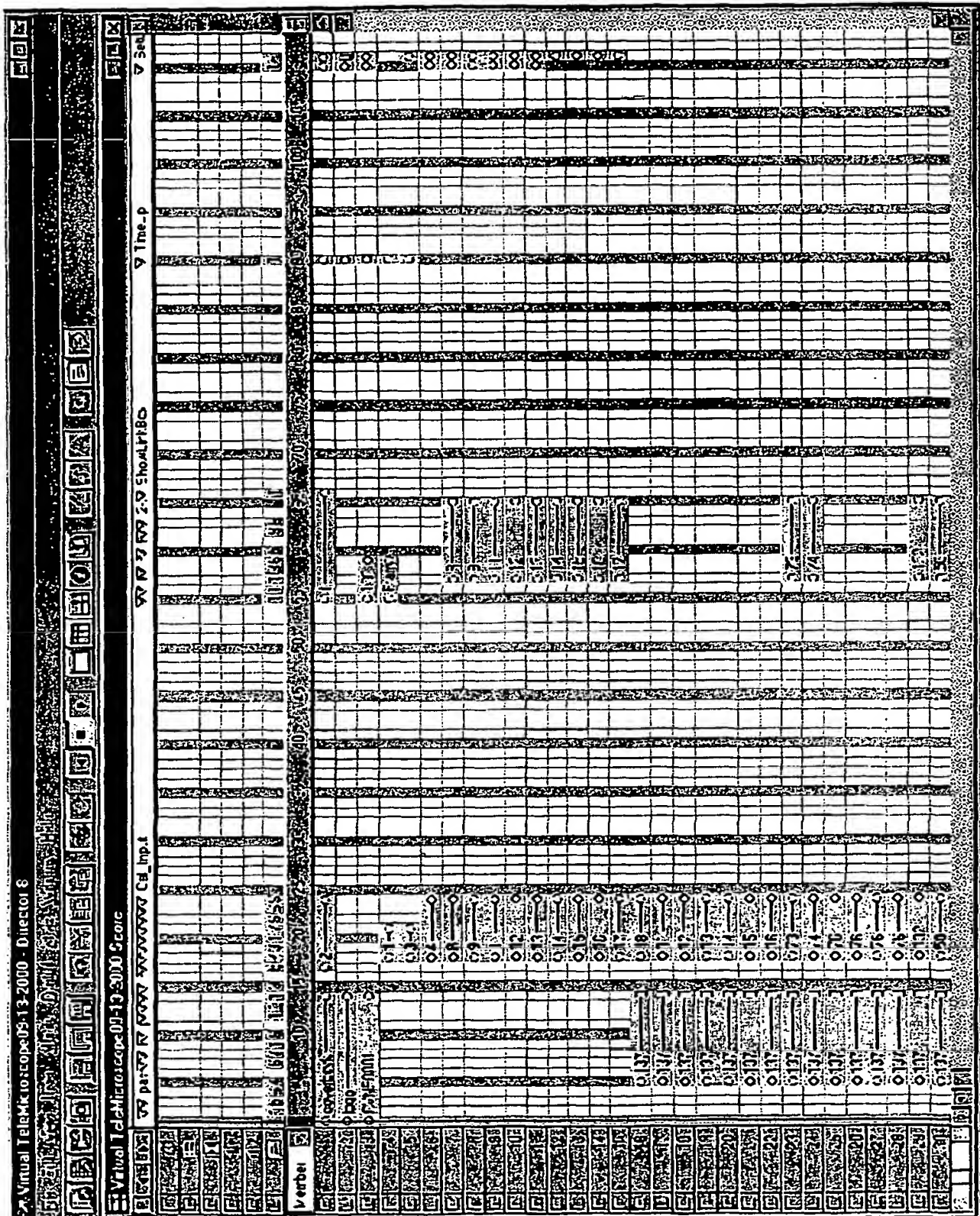
Reference/Comparison Flowchart:**FIG. 11i**Run Communication Software Flowchart:**FIG. 11j**

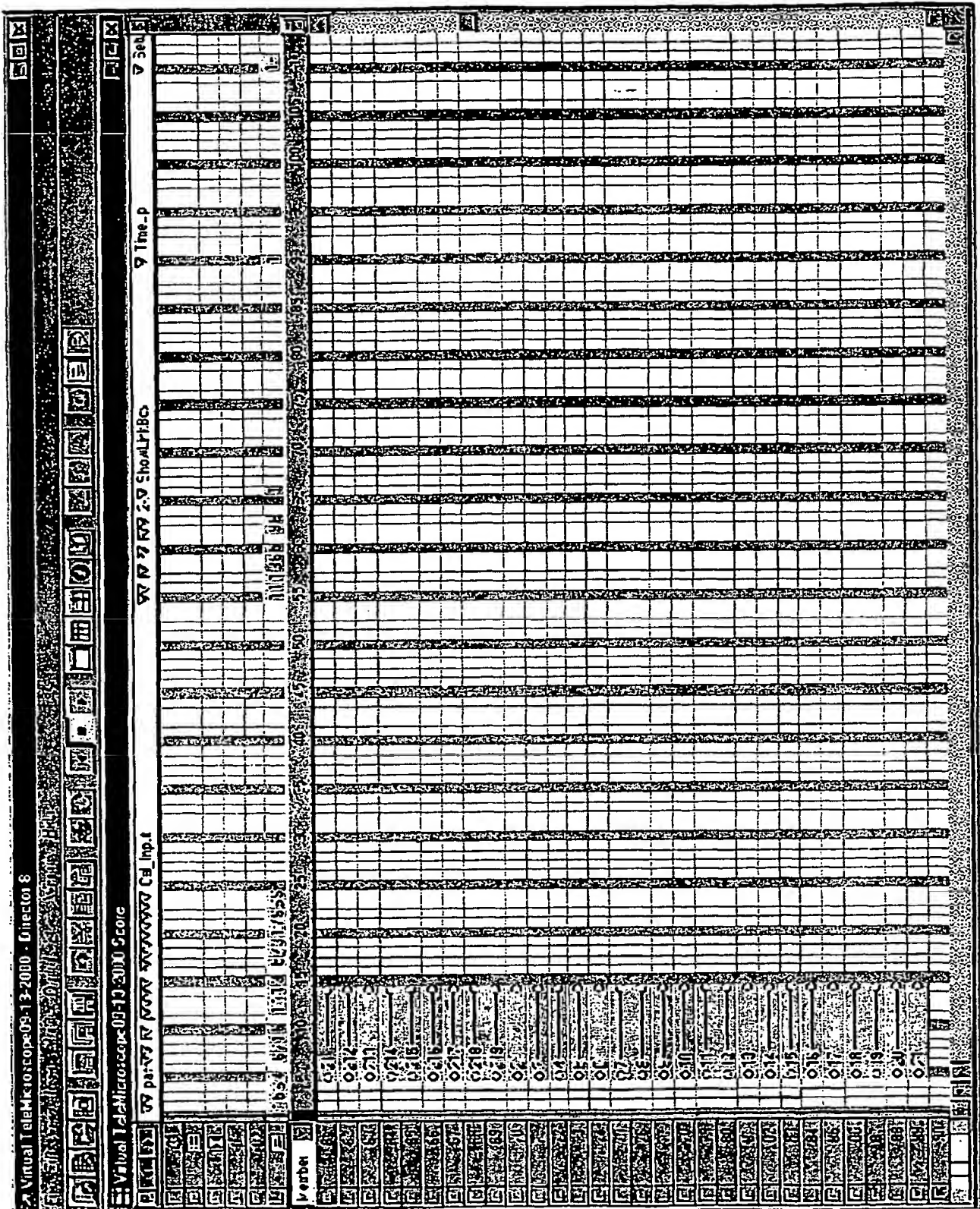
APPENDIX **A**

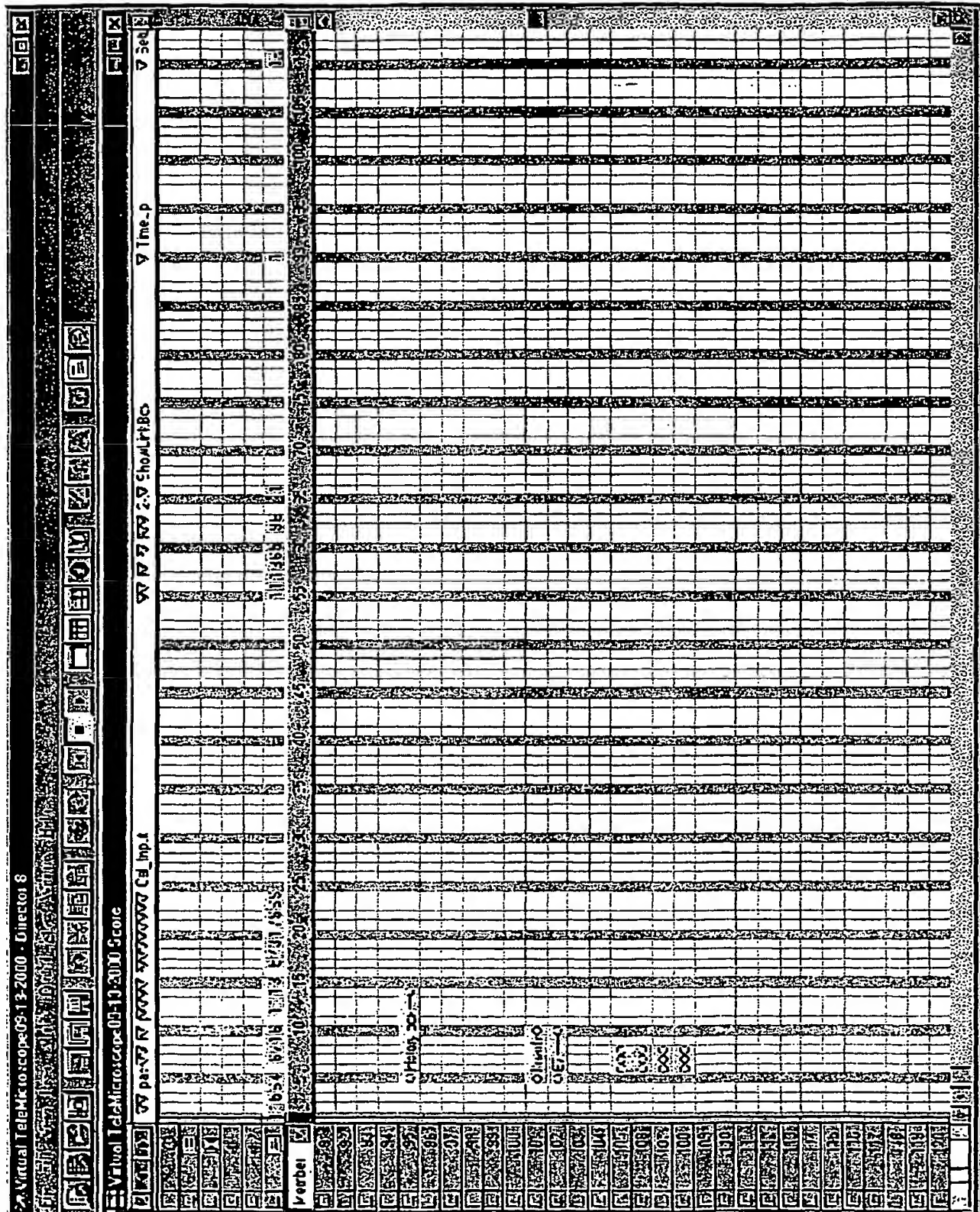
Software for the VT System

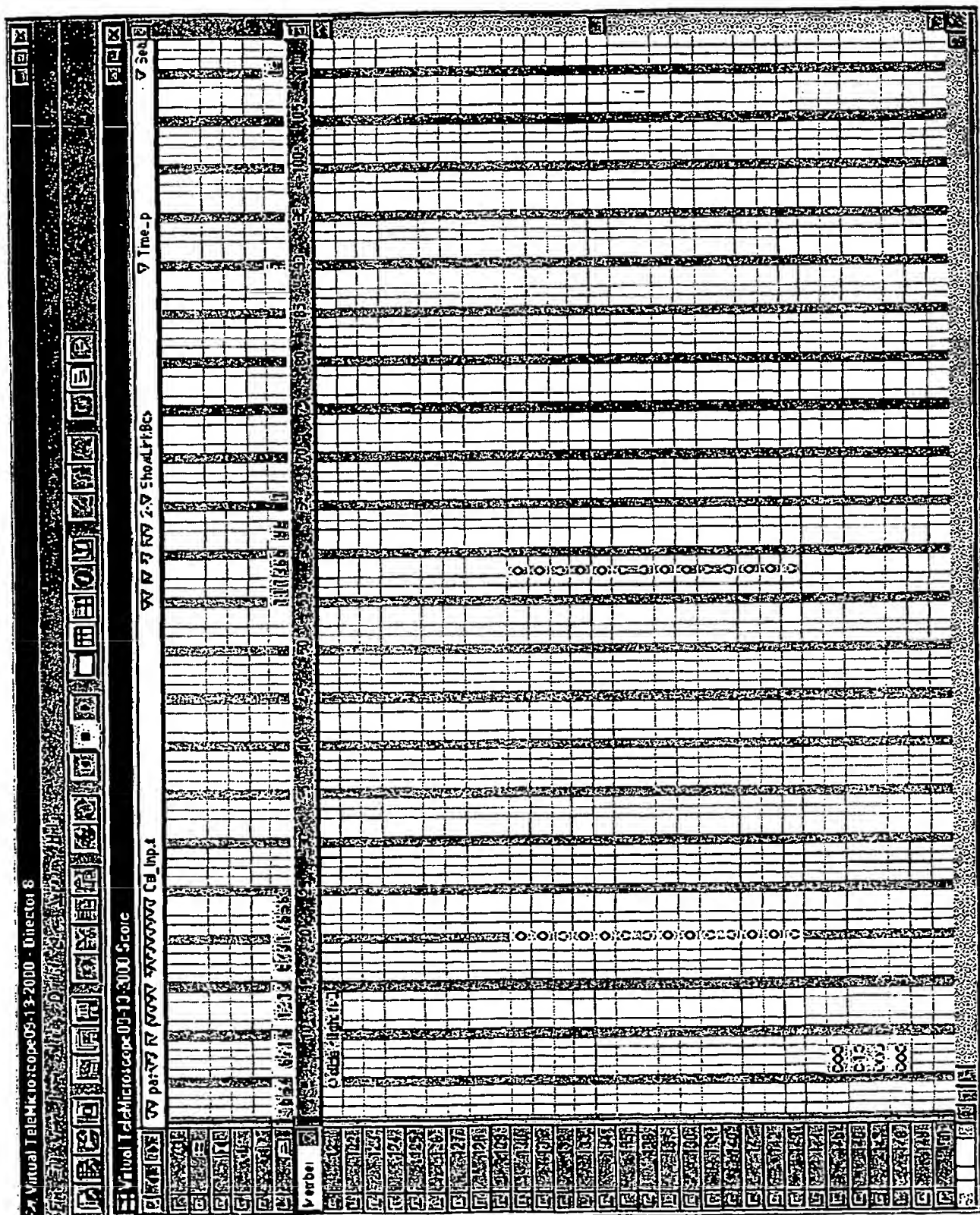
22\mst\table\starcop-0113-2000 - Director 8

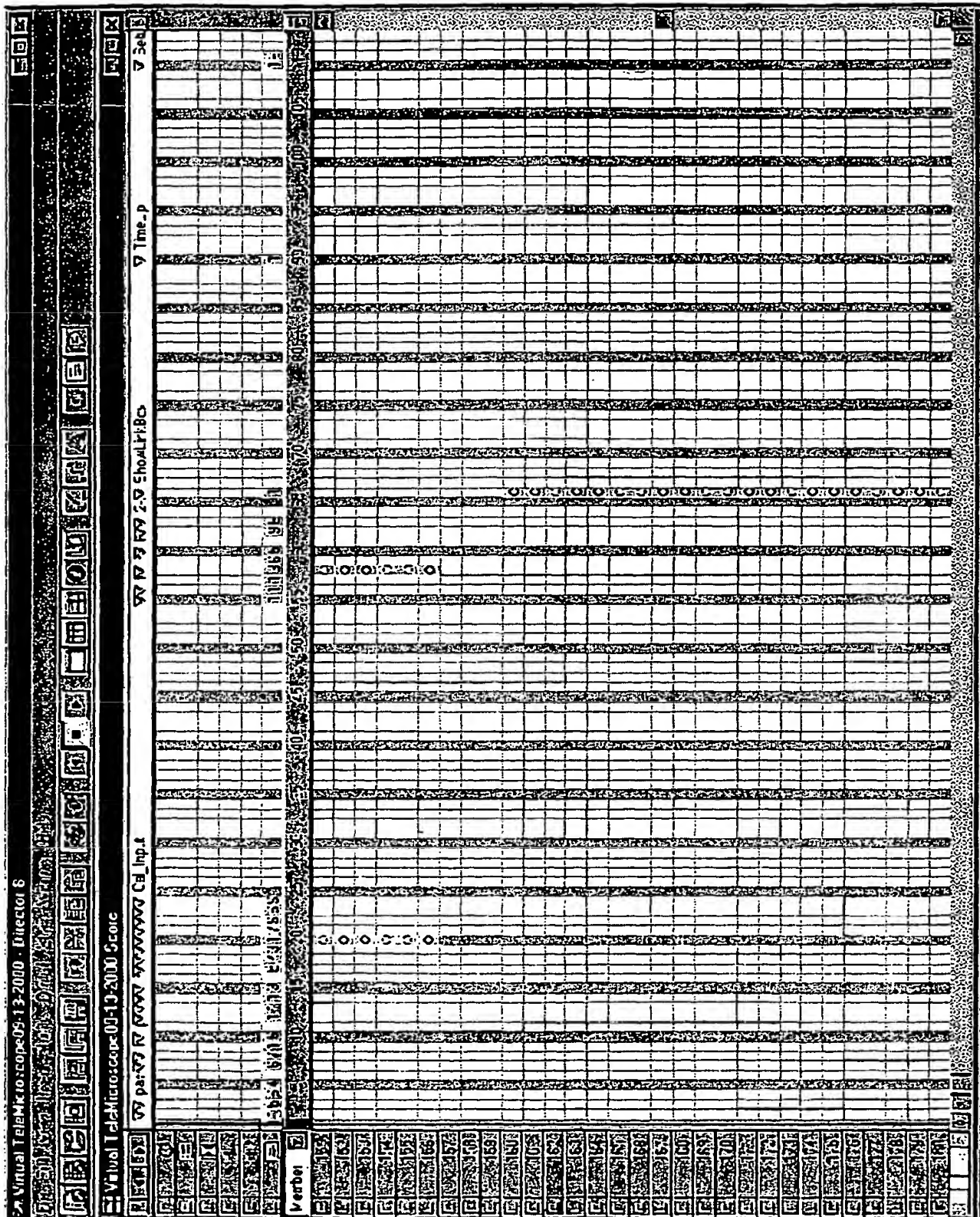
Internal Call

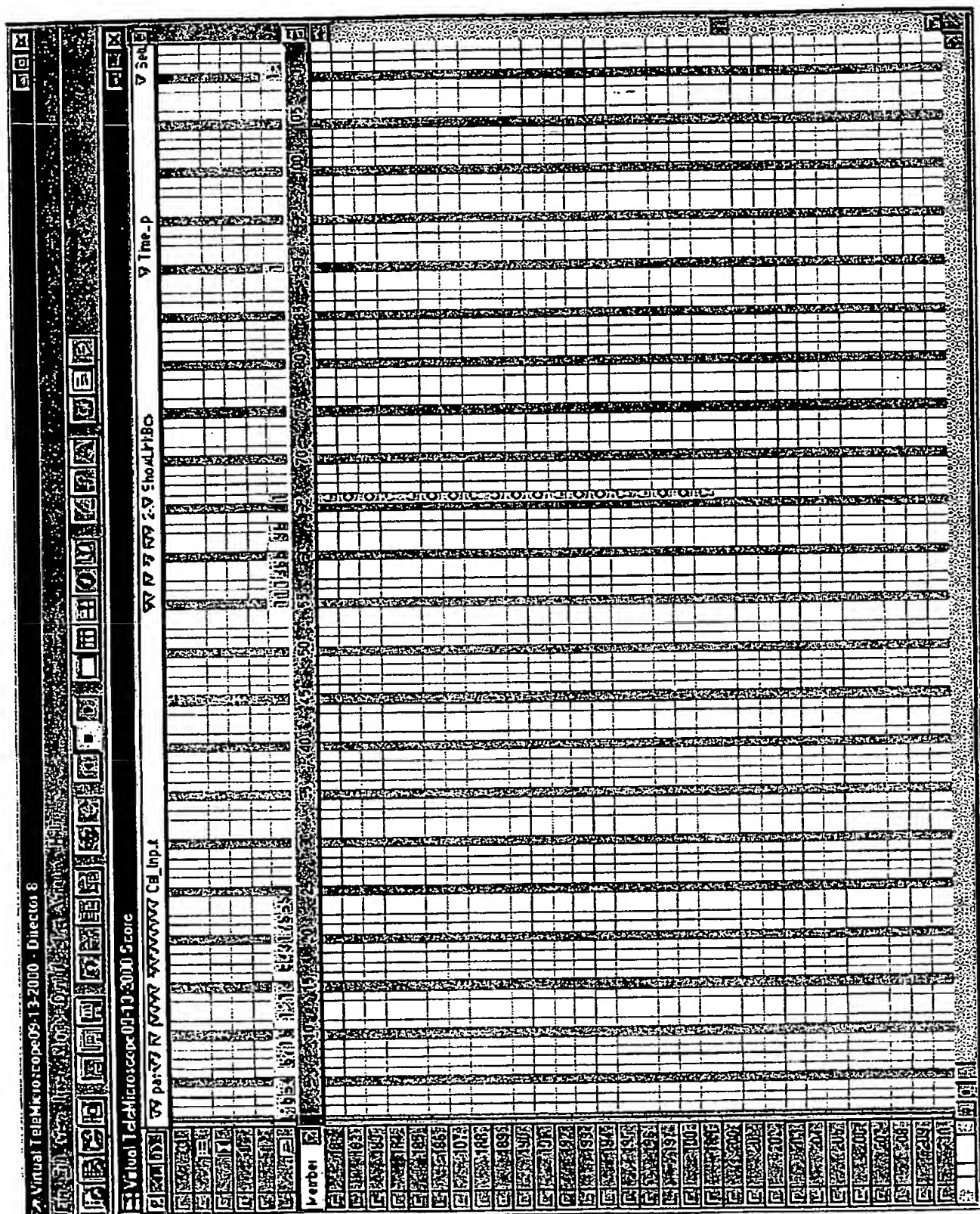


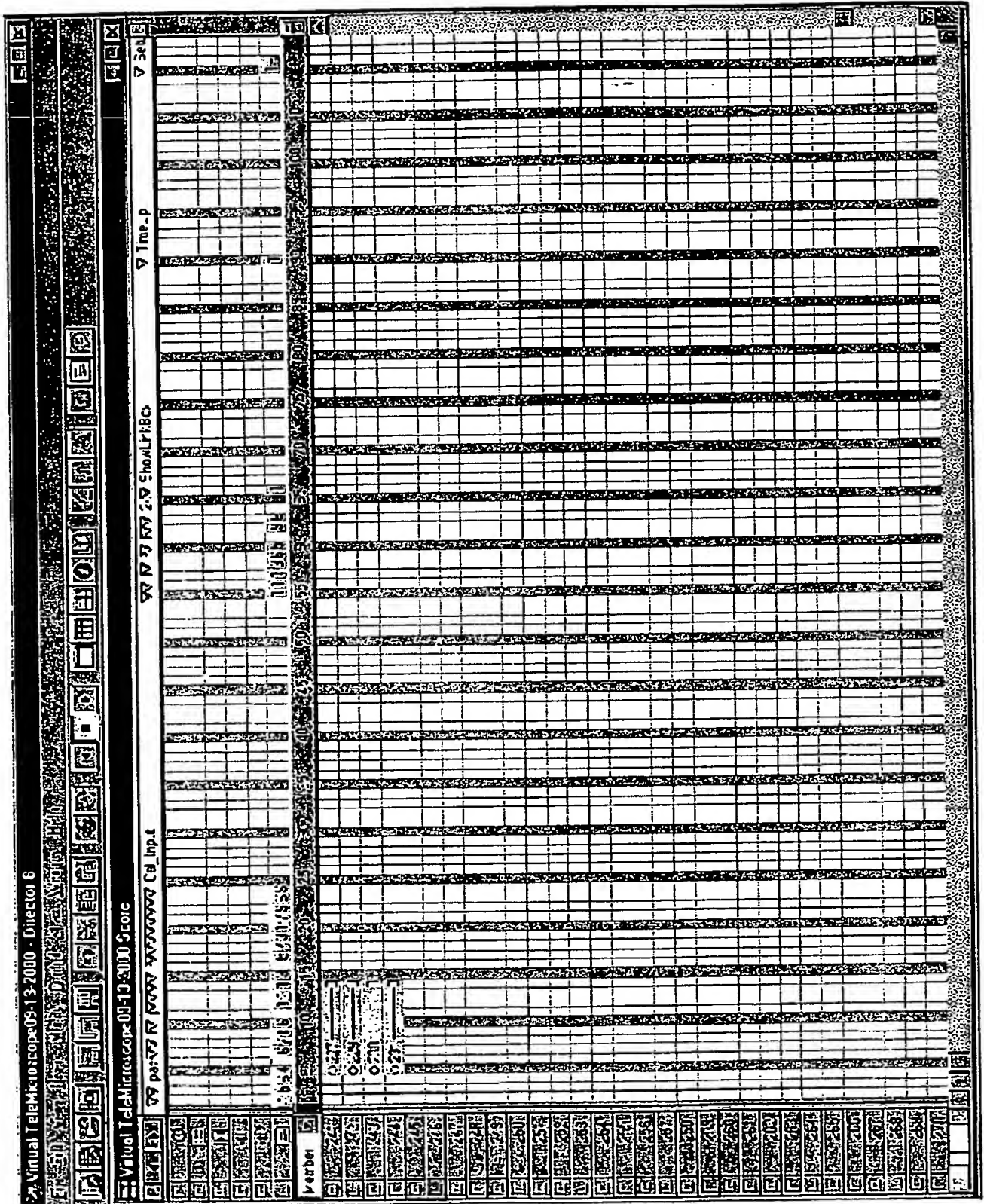


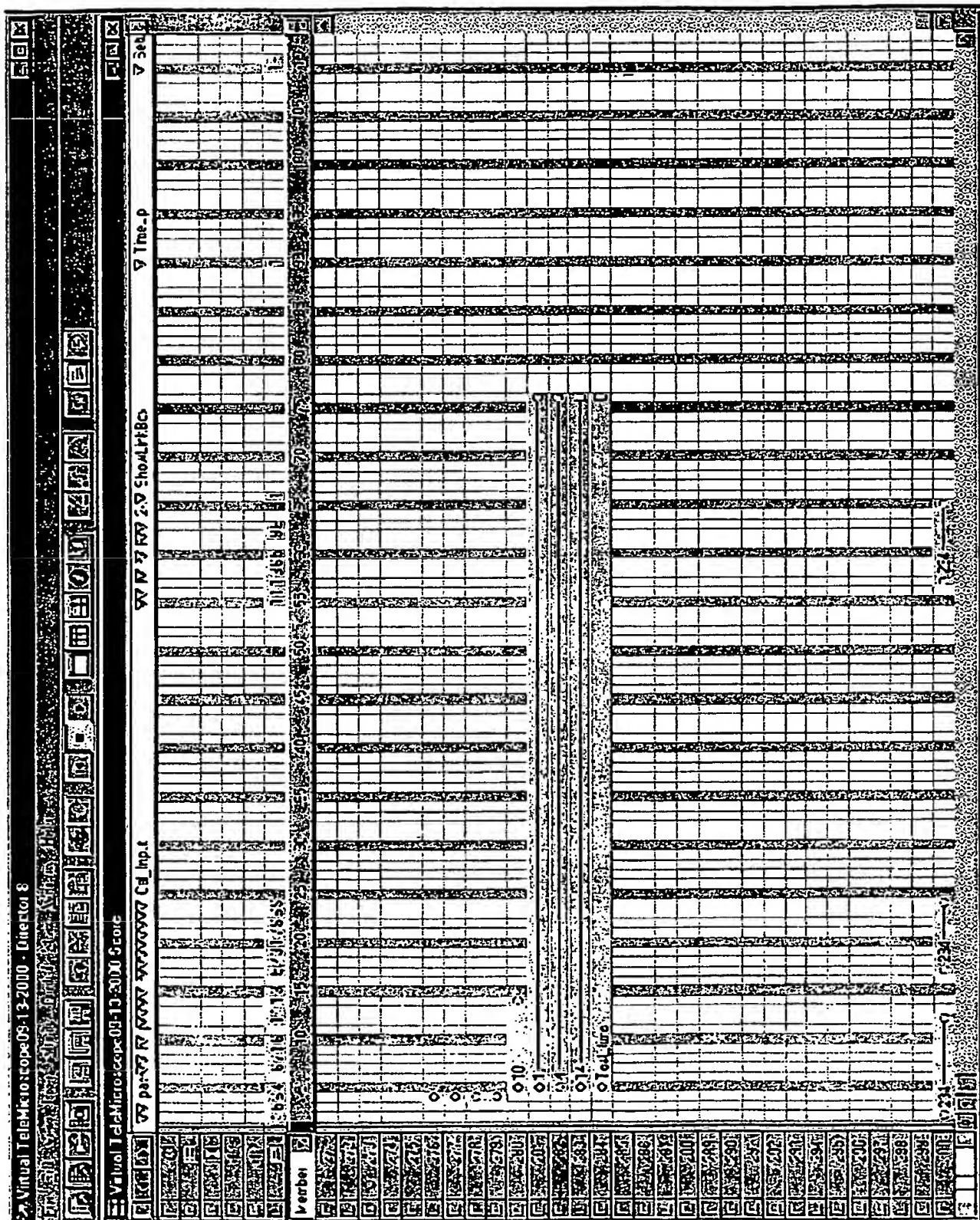












Macromedia Director 8.0 and Lingo programming language

Index File Retrieval Script

```

global picNum
global indexfilecast
global idxfile
global thumbfile
global RFileLoc
global IsURL
global RFilename
global RPath
global RURLFilename
global RURLPath
global TestMode
global StartClock
global IndexPath

on mouseUp
    clearCache
    clearCast()
    ClosePassword()
    set castlib("thumbnail").filename=the moviepath & "empty.cst"
    new(#text,member(1,"indexfile"))
    new(#text,member(4,"temp"))
    new(#text,member(5,"temp"))
    repeat with i=1 to 10
        set the visible of sprite (i+15) to false
        set the visible of sprite (i+25) to false
        set the visible of sprite (i+49) to false
        set the visible of sprite (i+59) to false
        set the visible of sprite (i+69) to false
        set the visible of sprite (i+79) to false
        set the visible of sprite (i+89) to false
    end repeat
    set member(67).text="Reading index file from location. Please
wait..."
    set the visible of sprite 102 to true
    updatestage
    if (member("url").text starts "http://") or (member("url").text
starts "ftp://") then
        set IsURL=True
        if the last char of member("url").text <> "/" then
            set member("url").text=member("url").text & "/"
        end if
        AppendHistoryFile
        set tmpLoc=member("url").text
        set ttlchar= the number of chars in tmpLoc
        if char ttlchar-3 to ttlchar of tmpLoc = ".txt" then
            RFileLoc=member("url").text
        else
            RFileLoc=member("url").text & "index.txt"        -- Filename is
assumed as Index.vtm
        end if
        IdentifyURL(RFileLoc)
        set idxfile=preloadnetthing(RFileLoc)
        set thumbfile=preloadnetthing(RURLPath & "thumbnail.cst")

```

```

set IndexPath=RURLPath
go to "loading"
if StartClock=True then
    Nothing
else
    if TestMode then
        StartTimer
        Set StartClock=true
    end if
end if
else
    set IsURL=false
    if fileexists(member("url").text)=0 then
        RfileLoc=member("url").text
        IdentifyFilename(RfileLoc)
        AppendHistoryFile
        set IndexPath=rpath
        set castlib("thumbnail").filename=rpath & RemoveExt(RFilename) &
        ".cst"
        importVTM(RfileLoc)
        go to "loading"
        if StartClock=True then
            Nothing
        else
            if TestMode then
                StartTimer
                Set StartClock=true
            end if
        end if
    else
        alert "The location" && member("url").text && "does not contain
Virtual Telemicroscope Index File. Please verify the location."
        set the visible of sprite 102 to false
        exit
    end if
end if
end

```

Virtual Slide Selection Script

```

global largepicturelist
global PicSelected
global indexfilecast
global currentldl
global currentPInfo
global IsURL
global RFilename
global RPath
global RURLFilename
global RURLPath
global BoxFilename
global BoxPointH
global BoxPointV
global BoxWidth
global BoxHeight
global PreloadComplete

```

property spritenum

on mouseenter

set the loc of sprite 121= the loc of sprite(spritenum)
set the visible of sprite 121 to true

end

on mouseleave

set the visible of sprite 121 to false

end

on mouseDown

if sprite(95).visible=false then
set the visible of sprite 101 to true
set member("loadingstatus").text="Loading Image..."
updatestage
PicSelected=spritenum-15
GetLinkBoxInfo()
filedownload()
end if

end

on FileDownload

new(#text,member(1,"temp"))
TextFileName=RemoveExt(largepicturelist[PicSelected])
if IsURL=true then
set currentldl=preloadnetthing(RURLPath &
largepicturelist[PicSelected])
set currentPInfo=preloadnetthing(RURLPath & TextFileName & ".txt")
go to "preparepic"
else
set currentldl=preloadnetthing(largepicturelist[PicSelected])
set currentPInfo=preloadnetthing(RPath & TextFileName & ".txt")
go to "preparepic"

end if

end

On GetLinkBoxInfo

set itemnum=1
set BoxItem=0
set BoxCount=1
BoxFilename=[]
BoxPointH=[]
BoxPointV=[]
BoxWidth=[]
BoxHeight=[]
PreloadComplete=[]
Repeat with i=1 to member(1,"indexfile").line[PicSelected].char.count
MyChar=member(1,"indexfile").line[PicSelected].char[i]
if MyChar="*" then
set itemnum=itemnum +1
if itemnum>2 then
set BoxItem=BoxItem+1
if BoxItem>5 then

```

        set tmpBoxFilename=empty
        set tmpBoxPointH=empty
        set tmpBoxPointV=empty
        set tmpBoxWidth=empty
        set tmpBoxHeight=empty
        set BoxItem=1
        set BoxCount=BoxCount+1
    end if
end if
next repeat
else
    if itemnum>2 then
        if BoxItem=1 then
            tmpBoxFilename=tmpBoxFilename & MyChar
            BoxFilename[BoxCount]=tmpBoxFilename
        else if BoxItem=2 then
            tmpBoxPointV= tmpBoxPointV & MyChar
            BoxPointV[BoxCount]=tmpBoxPointV
        else if BoxItem=3 then
            tmpBoxPointH= tmpBoxPointH & MyChar
            BoxPointH[BoxCount]=tmpBoxPointH
        else if BoxItem=4 then
            tmpBoxWidth=tmpBoxWidth & MyChar
            BoxWidth[BoxCount]=tmpBoxWidth
        else if BoxItem=5 then
            tmpBoxHeight=tmpBoxHeight & MyChar
            BoxHeight[BoxCount]=tmpBoxHeight
        end if
    end if
end if
end repeat
end

```

-- Index File Loading Script --

```

global largepicturelist
global picNum
global indexfilecast
global idxfile
global thumbfile
global startingsprite
global RFileLoc
global RURLPath
global IsURL
global IndexPath
global PwdCount

```

```

on exitFrame
    set NoThumbnail=false
    set thbstat=getstreamstatus(thumbfile)
    set idxstat=getstreamstatus(idxfile)
    if (getprop(idxstat,#error)="") or (getprop(idxstat,#error)="OK")
then
        if (not netdone(idxfile)) or (not netdone(thumbfile)) then
            if netdone(idxfile) and (not netdone(thumbfile)) then

```

```

    if getprop(thbstat,#bytestotal)<>0 then

DProg=(float(getprop(thbstat,#bytesSoFar))/float(getprop(thbstat,#bytes
total)))*100
    set member(67).text="Reading index file... Done" & return &
"Downloading slides..." && integer(DProg) & "% Completed."
    updatestage
    end if
    --      else
    --      set member(67).text="Reading index file... Done" &
return & "No slide picture available."
    --      set NoThumbnail=true
    --      end if
    else if (not netdone(idxfile)) and (not netdone(thumbfile)) then
    if getprop(idxstat,#error)=" " then
    if getprop(idxstat,#bytestotal)<>0 then

IProg=(float(getprop(idxstat,#bytesSoFar))/float(getprop(idxstat,#bytes
total)))*100
    set member(67).text="Reading index file..." &&
integer(IProg) & "% Completed."
    updatestage
    end if
    go the frame
    end if
    end if
    else if (netdone(idxfile)) and (netdone(thumbfile)) then
    set the visible of sprite 102 to false
    if IsURL=true then
    importfileinto member(4,"temp"),RFileLoc
    if member(4,"temp").type=#empty then
    alert "Index file contains no data or does not exists. Please
try another location."
    abort
    end if
    identifyURL(RFileLoc)
    if NoThumbnail=false then
    set castlib("thumbnail").filename=RURLPath & "thumbnail.cst"
    else
    -- No thumbnail routine here --
    end if
    else
    nothing
    end if
    if (member(4,"temp").line[member(4,"temp").line.count] contains
"Password= ") then
    set member(1,"indexfile").text=member(4,"temp").text
    else
    UnProtect(member(4,"temp"),member(1,"indexfile"))
    end if
    updatestage
    indexfilecast=199
    startingsprite=50
    repeat with k=50 to 120
    set the visible of sprite k to false
    end repeat

```

```

    largepicturelist=[]
    -- set the filename of castlib "indexfile"=member("url").text
& "index.cst"
    -- importfileinto member indexfilecast, member("url").text
& "index.txt"
    if member(1,"indexfile").type=#empty then
        alert "Index file contains no data. Please try another
location."
        abort
    end if
    picnum=member(1,"indexfile").line.count
    if picNum>20 then
        picnum=20
    else if picnum<=0 then
        set member(67).text="No file found in the location. Please try
another location."
        set the visible of sprite 102 to true
    else
        set picnum=picnum-1
    end if
    repeat with a=1 to picnum
        set largepicturelist[a]=empty
    end repeat
    -- if
member(1,"indexfile").line[member(1,"indexfile").line.count].word[2] =
empty and
member(1,"indexfile").line[member(1,"indexfile").line.count].word[1] =
"Password=" then
    -- LoadData
    -- go to the frame+1
    if
member(1,"indexfile").line[member(1,"indexfile").line.count].word[1] =
"Password=" then
        if
member(1,"indexfile").line[member(1,"indexfile").line.count].word[2] =
empty then
            LoadData
            go to the frame+1
        else
            set PwdCount=0
            TypePassword
            go to "pwdwait"
        end if
    else
        alert "Index File Corrupted. Please Try Another Location."
        go to "passed"
    end if
    --
    -- repeat with i=1 to picNum
    -- CharInLine=member(1,"indexfile").line[i].char.count
    -- repeat with j=1 to CharInLine
    -- MyChar=member(1,"indexfile").line[i].char[j]
    -- if MyChar="*" then
    -- new(#text,member(indexfilecast+i))
    -- set member(indexfilecast+i).width=300
    -- set member(indexfilecast+i).boxtype=#fixed
    -- if j=CharInLine then

```



```

--          set
member(indexfilecast+i).text=largepicturelist[i]
--          else
--          set member(indexfilecast+i).text=char j+1 to
CharInLine of member(1,"indexfile").line[i]
--          end if
--          exit repeat
--          else
--          largepicturelist[i]=largepicturelist[i] & MyChar
--          end if
--          end repeat
--          set the membernum of sprite(startingsprite+i-1) to
indexfilecast+i
--          end repeat
--          repeat with j=50 to 50+(picnum-1)
--          set the visible of sprite j to true
--          set the visible of sprite(j+20) to true
--          end repeat
--          updatestage
end if
else
  alert "Error downloading file. Please try another location." &
return & "Error Code: " & getprop(idxstat,#error)
  go to "passed"
  abort
end if
go the frame
end

```

```

-- Switch to Magnifying Glass Effect Script --
global MagGlass
global Microscope
global RulerOn

```

```

on mouseUp
  if MagGlass=true and Microscope=false then
    if RulerOn=true then
      set RulerOn=false
      go to "magnifying"
      set the visible of sprite 3 to true
      set the visible of sprite 4 to true
    else
      if the framelabel="ShowLinkBox" then
        go to "magnifying"
      end if
      if the visible of sprite 3=true then
        set the visible of sprite 3 to false
        set the visible of sprite 4 to false
      else
        set the visible of sprite 3 to true
        set the visible of sprite 4 to true
      end if
    end if
  else
    set MagGlass=true
  end if
end if

```

```
    set Microscope=False
    go to "magnifying"
    set the visible of sprite 3 to true
    set the visible of sprite 4 to true
end if
end

-- Switch to Microscope Effect Script --

global viewerheight
global viewerwidth
global viewerloc
global smallpicheight
global smallpicwidth
global smallpicloc
global ruler
global RulerOn      --Check ruler on/off
global cal
global dropdown
global MagGlass
global Microscope
global PicToScreenRatio

on mouseUp
  if MagGlass=false and Microscope=true then
    if RulerOn=True then
      set RulerOn=false
      go to "2nd"
      set the visible of sprite 4 to true
      set the visible of sprite 5 to true
    else
      if the framelabel="ShowLinkBox" then
        go to "2nd"
      end if
      if the visible of sprite 4=true then
        set the visible of sprite 4 to false
        set the visible of sprite 5 to false
      else
        set the visible of sprite 4 to true
        set the visible of sprite 5 to true
      end if
    end if
  else
    set MagGlass=false
    set Microscope=true
    set smallpicheight=member(1).height
    set smallpicwidth=member(1).width
    set smallpicloc=point(233, 189)
    set viewerheight=smallpicheight*0.25
    set viewerwidth=smallpicwidth*0.25
    viewerloc=point(233, 189)
    set dropdown=false
    set the visible of sprite(5) to true
    set the visible of sprite(4) to true
    -- set the height of sprite 5 to viewerheight
    -- set the width of sprite 5 to viewerwidth
    -- set the height of sprite 4 to member(1).height
```

```

-- set the width of sprite 4 to member(1).width
set the linesize of sprite 5 to 2
ruler=34 --Ruler spriteNum
set cal=false
set RulerOn=false
go to "2nd"
GoRightBottom()
end if
updatestage
end

```

```

On GoRightBottom
if member(2).height<member(2).width then
set the width of sprite 4 to 192
else
set the width of sprite 4 to 148
end if
C_ViewerSize()
set the width of
sprite(5)=float(sprite(4).width)/((PicToScreenRatio)*2.2)
C_MagnifierSize()
sprite(4).rect=rect(800-the width of sprite 4,600-the height of
sprite 4,800,600)
updatestage
end if

```

```
-- Link Images Script --
```

```

global BoxFilename
global BoxPointH
global BoxPointV
global BoxWidth
global BoxHeight
global LinkStatus
global GoToLink
global HistoryFile
global MagGlass
global Microscope
global LinkHistory

on mouseUp
if LinkStatus=False then
if BoxFilename<>void then
if BoxFilename.count>0 then
if the framelabel="ShowLinkBox" then
ToggleLinkBox(False)
if getAProp(LinkHistory,#MagGlass)=true then
go to "Magnifying"
else
go to "2nd"
end if
else..
set LinkHistory=[]
setAProp(LinkHistory,#MagGlass,MagGlass)
setAProp(LinkHistory,#Microscope,Microscope)

```

```

        go to "ShowLinkBox"
        new(#bitmap,member(196))
        new(#bitmap,member(220))
        set member(196).image=member(1).image.duplicate()
        set member(220).image=member(2).image.duplicate()
        AllLinkBoxesOff()
        ShowBoxes()
    end if
    else
        alert "There is no linked image for this image."
    end if
    else
        alert "There is no linked image for this image."
    end if
    else
        set LinkStatus=false
        set GoToLink=True
        erase member(1)
        erase member(2)
        erase member(190)
        erase member(198)
        -- importfileinto member(2) HistoryFile
        -- set the filename of member(190) to HistoryFile
        -- set the filename of member(198) to HistoryFile
        new(#bitmap,member(1))
        new(#bitmap,member(2))
        new(#bitmap,member(190))
        new(#bitmap,member(198))
        set member(1).image=member(196).image.duplicate()
        set member(2).image=member(220).image.duplicate()
        set member(190).image=member(220).image.duplicate()
        set member(198).image=member(220).image.duplicate()
        go to "start"
    end if
end

-- Microscope Effect Script --

on prepareframe
    set the linesize of sprite 5 to 2
end

on exitFrame
    if rollover(8) then
        ShowMicmenu()
    else
        HideMicMenu()
    end if
    set the rect of sprite 1 = map(the rect of sprite 4, the rect of
    sprite 5, the rect of sprite 6 )
    updatestage
    go the frame
end

```

```

-- Magnifying Glass Effect (Using Lens Behavior) --

-- Lens behavior
--
-- Info on use is in the behavior description.
--
-- For scripters, we're moving the regpoint of the masking graphic
-- in the opposite direction to that of the drag of the lens.
-- If the altered graphic is larger than the regular background and
-- the lens appears to magnify the background, then the mask's
regPoint is
-- moved with a scaling factor, and the larger graphic is sent in the
-- direction opposite to this. (Confusing -- see stepFrame method.)
--
-- When the behavior is dragged atop a lens graphic then the routine
checks
-- that there is actually a valid masked graphic in a lower channel.
This check
-- is performed again at runtime, just in case sprites were moved
about
-- after the time that the behavior was assigned.
--
-- When the lens is clicked a reference to the behavior is added to
the actorList.
-- This is preferable to use of a tight repeat loop because other
things can still occur
-- in your movie -- animations can play, sounds or videos can run,
your email can still arrive.
-- The stepFrame method checks against the mouse being released and
will remove itself
-- from the actorList when the user stops dragging the lens.
--
-- Note the Error handler at the end of the set of standard behavior
routines...
-- this makes the "FindAndVerifyMasks" routine easier to read, because
the
-- handling of an error is separated from the testing of the error.
--
--
-- History:
-- 10/23/97 jd Added magnification, changed regPoint retention,
rewrote docs.
-- 10/22/97 jd Written as D6 behavior.
-- 6/15/94 jd Hardwired for Director 4.
global myMagnification
global PicRatio

property spriteNum, myOrigLoc, myOrigReg
global myMaskedLoc, myMask , myMaskedSprite --, myMagnification

----- EXTERNAL EVENTS -----

on beginSprite me
-- set mymagnification="1"
FindAndVerifyMasks me
-- SetMagnifyingFactor me

```

```

-- ResetMaskRegPoint me
end

on endSprite me
  ResetMaskRegPoint me
end

on mouseDown me
  set myOrigLoc to the loc of sprite spriteNum
  set myOrigReg to the regPoint of member myMask
  set myMaskedLoc to the loc of sprite myMaskedSprite
  add the actorList, me
end

on stepFrame me
  if the mouseUp then deleteOne(the actorList, me)
  set newOffset to point(the mouseH, the mouseV) - the clickLoc --
  set the loc of sprite spriteNum to myOrigLoc +
  newOffset*(1+myMagnification*PicRatio)
  set the regPoint of member myMask to myOrigReg - myMagnification *
  newOffset
  set the loc of sprite myMaskedSprite to myMaskedLoc -
  (myMagnification - 1) * newOffset
end

----- SUBROUTINES -----

-- Makes sure there's a sprite with a lower channel with a 'mask' ink,
-- and that the graphic following this image is a proper 1-bit mask.
-- Also checks that background-transparent ink is applied to the lens.
-- Called by beginSprite and getPropertyDescriptionList.

on FindAndVerifyMasks me
  set myMaskedSprite to 0
  repeat with i = the currentSpriteNum down to 1
    if the ink of sprite i = 9 then set myMaskedSprite to i
  end repeat
  if myMaskedSprite = 0 then Error me, #noMaskedSpriteFound
  set maskedMember to the number of the member of sprite myMaskedSprite
  set myMask to member (maskedMember + 1)
  if the type of myMask <> #bitmap then Error me, #noMaskFound
  if the depth of member myMask > 1 then Error me, #incorrectMaskDepth
  if the ink of sprite (the currentSpriteNum) <> 36 then Error me,
  #wrongInkOnLens
end

-- Turns the informative string option presented in getPropDesc
-- to a numeric magnification factor for scaling.
-- Called by beginSprite.

on SetMagnifyingFactor me
  delete the last char of myMagnification
  delete the last char of myMagnification
  set myMagnification to value(myMagnification)

```

end

```
-- Centers the regPoint of the 1-bit masking graphic,
-- initializing the process. (Changes to member properties persist
-- through the session, unlike changes to sprite properties.)
-- Called by beginSprite and endSprite.
```

```
on ResetMaskRegPoint me
  set theH to integer((the right of the rect of member myMask) / 2)
  set theV to integer((the bottom of the rect of member myMask) / 2)
  set the regPoint of member myMask to point(theH, theV)
end
```

----- STANDARD BEHAVIOR ROUTINES -----

```
--on getPropertyDescriptionList me
-- if the currentSpriteNum <> 0 then FindAndVerifyMasks me
-- return [#myMagnification: [#comment: "What magnification of channel
" & myMaskedSprite & " to the background?", #format: #string,
#range:["1:1", "1.5:1", "2:1", "2.5:1", "3:1"], #default: 1]]
--end
```

```
on getBehaviorDescription me
  set line1 to "This behavior, when applied to a visible 'lens' type of
graphic, will appear to change the contents of an underlying graphic.
It does so by manipulating the mask of a mostly-invisible graphic
between the lens and the background image. You can appear to magnify
the background by using a larger altered image sandwiched between the
background and the lens." & RETURN & RETURN
```

```
  set line2 to "Examples include being able to drag a background-
transparent circle around to see a pseudo-filtered version of the
underlying graphic, or being able to drag a reading bar across a
graphic in one language to translate it, or being able to look at the
skeleton of an animal on display, or finding secret messages in a
picture." & RETURN & RETURN
```

```
  set line3 to "To use:" & RETURN
  set line4 to "1) Make your normal background, the altered version,
and your lens graphics. If magnifying, make the altered version 1.5
times as large, or 2 times as large, etc." & RETURN
```

```
  set line5 to "2) Make a masking graphic that fits precisely inside
the visible area of your lens. You can use onion skinning to make it,
or duplicate the lens and fill it with black before deleting non-black
pixels, or make the mask first and use it to knock out the proper area
of the lens. The mask defines which area of the altered graphic will be
seen through the lens." & RETURN
```

```
  set line6 to "3) Use 'Transform Bitmap' on the masking graphic to
turn it to 1-bit color. Place it in the cast immediately following your
graphic of the altered background. (For instance, if you have an
animal, its skeleton, and a lens, then put the mask right after the
skeleton in the cast.)" & RETURN
```

```
  set line7 to "4) Select the normal and altered graphics and drag
them to the Stage. The altered graphic should be precisely atop the
normal graphic. Give the altered graphic a 'mask' ink. (Result: you
should see only the shape of the lens altered. If you wish to change
```

the relative location of this mask, then change the regPoint of the 1-bit graphic in the Paint Window.)" & RETURN

set line8 to "5) Drag the lens graphic onto the Stage, set its ink and desired magnification, and position it right above your masked area. It will appear as if your lens is outlining the altered area." & RETURN

set line9 to "6) Finally assign this behavior to the lens, start the movie, and drag the lens around. You should see the altered area of the graphic change, as if the lens is really affecting the background." & RETURN & RETURN

set line10 to "Tips:" & RETURN

set line11 to "-- Dragging smoothness is controlled by the framerate of the movie." & RETURN

set line12 to "-- Large graphics or high colordepths can slow dragging." & RETURN

set line13 to "-- If they drag the lens outside of the graphic boundaries they'll see the white of the Paint Window's canvas. You can paste the altered graphic against a rectangle of the background color in the Paint Window, if speed is not adversely affected." & RETURN

set line14 to "-- This routine currently relies upon the background, the altered graphic, and the lens all sharing the same centerpoint on the Stage. It should be possible to set up custom starting points, although this can be tricky to visualize while authoring." & RETURN

return line1 & line2 & line3 & line4 & line5 & line6 & line7 & line8 & line9 & line10 & line11 & line12 & line13 & line14
end

-- Generic error handler.

-- Mostly called by FindAndVerifyMasks routine.

on Error me, whatError

case (whatError) of

#noMaskedSpriteFound: alert "There needs to be an altered image with the 'mask' ink in a channel lower than the lens in channel " & the currentSpriteNum & "."

#noMaskFound, #incorrectMaskDepth: alert "The castmember immediately following your altered graphic in channel " & myMaskedSprite & " needs to be a 1-bit graphic mask."

#wrongInkOnLens: alert "The ink for this draggable lens needs to be background-transparent."

end case

-- This undefined handler will halt operation

-- and call up the debugger window for you...

-- you can replace it with "halt" if you wish:

debug()

end

-- Link Images Sub Functions Script --

Global BoxFilename

Global BoxLinkFile

Global RURLPath

global BoxPointH

global BoxPointV

global BoxWidth

global BoxHeight

global PreloadComplete

global IsURL

```
On ToggleLinkBox OnOrOff
  repeat with i=1 to BoxFilename.count
    set the visible of sprite (159+i) to OnOrOff
  end repeat
end
```

```
On LinkPicPreload
  if BoxLinkFile<=BoxFilename.count then
    FileStateInfo=getStreamStatus(RURLPath & BoxFilename[BoxLinkFile])
    if FileStateInfo.state="Complete" then
      set PreloadComplete[BoxLinkFile]=true
      if the framelabel="ShowLinkBox" then
        ShowLinkBoxFrame(BoxLinkFile)
      end if
      set BoxLinkFile=BoxLinkFile +1
      LinkPicPreload()
    else
      set CurrentDLLink=Preloadnetthing(RURLPath &
BoxFilename[BoxLinkFile])
      set member(185).text="Image" && BoxLinkFile && "of" &&
BoxFilename.count
    end if
  else
    set member(185).text="Completed"
    set the rect of sprite 231=rect(17,21,172,39)
    abort
  end if
end
```

```
on streamStatus URL, state, bytesSoFar, bytesTotal
  if state = "Complete" then
    set PreloadComplete[BoxLinkFile]=true
    if the framelabel="ShowLinkBox" then
      ShowLinkBoxFrame(BoxLinkFile)
    end if
    if BoxLinkFile<=BoxFilename.count then
      set BoxLinkFile=BoxLinkFile +1
      set the rect of sprite 231=rect(17,21,17,39)
      LinkPicPreload()
    else
      set PreloadComplete[BoxLinkFile]=false
      -- tellstreamstatus(False)
    end if
  -- else if state="Error" then
  --   alert "An error occur while trying to download " & URL & ". VT
will skip this file"
  else
    set percentage=float(bytesSoFar)/float(bytesTotal)
    set BarLength=155 * percentage
    set the rect of sprite 231=rect(17,21,17+BarLength,39)
  end if
end streamStatus
```

```
On AllLinkBoxesOff
  repeat with i=1 to 20
    set the visible of sprite (159+i) to false
    set the visible of sprite (179+i) to false
  end repeat
end

On CheckBoxFileStatus TheUrl
  -- tellstreamstatus(true)
  FileStateInfo=getStreamStatus(TheUrl)
  if FileStateInfo.state<>"Complete" then
    alert "Image Not Ready, Please Try Again Later."
    abort
  end if
end

On ShowBoxes
  repeat with i=1 to BoxFilename.count
    set the loc of sprite 159+i to
point(integer(BoxPointH[i]),integer(BoxPointV[i]))
    set the width of sprite 159+i to integer(BoxWidth[i])
    set the height of sprite 159+i to integer(BoxHeight[i])
    if IsURL=true then
      ShowLinkBoxFrame(i)
    else
      ShowAllLinkBoxFrame(i)
    end if
  end repeat
  ToggleLinkBox(True)
  updatestage
end

On ShowLinkBoxFrame(WhichBox)
  if WhichBox<=PreloadComplete.count then
    if PreloadComplete[WhichBox]=true then
      set the loc of sprite (179+WhichBox) to
point(integer(BoxPointH[WhichBox]),integer(BoxPointV[WhichBox]))
      set the width of sprite (179+WhichBox) to
integer(BoxWidth[WhichBox])
      set the height of sprite (179+WhichBox) to
integer(BoxHeight[WhichBox])
      set the visible of sprite (179+WhichBox) to true
    end if
  end if
end

On ShowAllLinkBoxFrame WhichBox
  set the loc of sprite (179+WhichBox) to
point(integer(BoxPointH[WhichBox]),integer(BoxPointV[WhichBox]))
  set the width of sprite (179+WhichBox) to integer(BoxWidth[WhichBox])
  set the height of sprite (179+WhichBox) to
integer(BoxHeight[WhichBox])
  set the visible of sprite (179+WhichBox) to true
end
```

-- Main Program Settings and Related Sub Functions --

```

global largepicturelist
global picNum
global indexfilecast
global idxfile
global startingsprite
global PicSelected
global RPath
global RFilemae
global RURLPath
global RURLFilename
global IsURL
global Boxfilename
global GoToLink
global MagCalibrated, MicCalibrated, unit, LengthPerPixel
global Microscope
global MagGlass
global IsTrial, IsCDCheck, IsViewer, IsTest
global CDVerifyString
global ProgramVersion
global TestTime
global PassTrial
global TypedPass
global Def_TTime
global Def_TLocation
global Def_TPassword

On Preparemovie
  the editShortCutsEnabled=1
  set IsTrial=False                      -- Set if program is 30-days
Trial
  set IsCDCheck=False                   -- Set if CD-Check is active
  set IsViewer=False                   -- Set if program is Viewer
Only version(No Prepare Button)
  set IsTest=False                     -- Set If Program is Test
Version/Mode(With clock shows up)
  set CDVerifyString="vt\vt2\vt2.exe"  -- Set the CD-Check checking
file path
  set ProgramVersion=0019              -- Set the program version to
update Trial Period to 30 days. 9001 special test Version
  if IsTest=True then                 -- DO NOT EDIT THIS LINE!!!! -
-
  -- *** Test Version/Mode Declaration *** --
  -- set TestTime=1*3600                -- Test Time
  set PassTrial=3                      -- Trial(s) for
Administrator Setup Password Prompt
  set member(26,"Timer").text=empty    -- Clear Administrator Setup
Password Box
  set TypedPass=empty                 -- Clear Internal Password
Variable for Administrator Setup
  set Def_TTime=5                      -- Default Test Time
  set Def_TLocation="http://199.33.133.94/vt/" -- Default Test
Location
  set Def_TPassword="cb"               -- Default Password

```

```

        Get_TestFile()
test.dat
    set member("url").text=empty
    -- *** End Test Vesion Declaration/Initialization *** --
end if
    -- ***          RULER CALIBRATION SETTING          *** --
    -- *** Predefined Setting Using Polaroid SprintScan 4000 *** --
    set MagCalibrated=true
    calibrated for Magnifying Glass
    set MicCalibrated=true
    calibrated for Microscope
    set unit="um"
    calibration/Ruler
    set LengthPerPixel=30000.0/4596.0
    divide by pixel. Use dafault Unit to set Unit.
    -- ***          END RULER CALIBRATION SETTING          *** --
    tellstreamstatus(true)
    set BoxFilename=empty
    set GoToLink=false
    set MagGlass=true
    set Microscope=false
    set castlib("thumbnail").filename=the moviepath & "empty.cst"
    CheckFile()
    set the exitlock to true
    set the rect of the stage to rect(0,0,800,600)
    set the centerstage to true
    -- cachedocverify #always
    set FloatPrecision=0
    set IsURL=False
    set LinkStatus=False
    set GoToLink=False
    ClosePassword()
    if cacheSize()<5000 then
        cacheSize 5000
    end if
    repeat with i=1 to 150
        if i<=21 then
            member(i,"thumbnail").erase()
        end if
        set the visible of sprite i to true
    end repeat
end

On RemoveExt filenamestring
    repeat with i=(the number of chars of filenamestring) down to 1
        if char i of filenamestring="." then
            delete char i of filenamestring
            exit repeat
        else
            delete char i of filenamestring
        end if
    end repeat
    set TrueFilename=empty
    repeat with j=(the number of chars of filenamestring) down to 1
        if char j of filenamestring="\\" then
            exit repeat
        end if
    end repeat

```

```
    else
        TrueFilename=char j of filenamestring & TrueFilename
    end if
end repeat
return TrueFilename
end

On PopupInfo
if member(1,"temp").type=#empty then
    set member("ID").text="N/A"
    set member("Date").text="N/A"
    set member("General").text="No Data Available For This Image."
    set member("Comment").text="No Comment Available For This Image."
    set member("Source").text="N/A"
    set member("Pemail").text="N/A"
    set member("PFileAttach").forecolor=8
else
    set member("ID").text=member(1,"temp").line[1]
    set member("Date").text=member(1,"temp").line[2]
    set member("General").text=member(1,"temp").line[3]
    set member("Comment").text=member(1,"temp").line[4]
    set member("Source").text=member(1,"temp").line[5]
    set member("Pemail").text=member(1,"temp").line[6]
    if member(1,"temp").line[7]=empty then
        set member("PFileAttach").forecolor=8
    else
        set member("PFileAttach").forecolor=255
    end if
end if
end

On ClosePopup
set member("ID").text=empty
set member("Date").text=empty
set member("General").text=empty
set member("Comment").text=empty
set member("Source").text=empty
set member("Pemail").text=empty
set member("PFileAttach").forecolor=255
end

On TypePassword
set member("url").editable= false
set the visible of sprite 145 to true
set the visible of sprite 146 to true
set the visible of sprite 147 to true
set the visible of sprite 148 to true
end

On ClosePassword
set member("url").editable= true
set the visible of sprite 145 to false
set the visible of sprite 146 to false
set the visible of sprite 147 to false
set the visible of sprite 148 to false
```

end

On RemovePath fullpath

```

repeat with i=(the number of chars of fullpath) down to 1
  if char i of fullpath="/" then
    exit repeat
  else
    delete char i of fullpath
  end if
end repeat
return fullpath
end

```

On LoadData

```

repeat with i=1 to picNum
  set tmpFileLoc=empty
  set tmpIndexFileCast=empty
  new(#text,member(indexfilecast+i))
  set member(indexfilecast+i).width=60
  set member(indexfilecast+i).height=80
  -- set member(indexfilecast+i).boxtype=#fixed
  CharInLine=member(1,"indexfile").line[i].char.count
  set itemnum=1
  repeat with j=1 to CharInLine
    MyChar=member(1,"indexfile").line[i].char[j]
    if MyChar="*" then
      set itemnum=itemnum+1
      next repeat
    else
      if itemnum=1 then
        tmpFileLoc=tmpFileLoc & MyChar
        set largepicturelist[i]=tmpFileLoc
      else if itemnum=2 then
        tmpIndexFileCast=tmpIndexFileCast & MyChar
        set member(indexfilecast+i).text=tmpIndexFileCast
        if (member(indexfilecast+i).text=empty) then
          set member(indexfilecast+i).text=largepicturelist[i]
        end if
      else
        exit repeat
      end if
    end if
  end if
  -- if itemnum=2 then
  --   new(#text,member(indexfilecast+i))
  --   set member(indexfilecast+i).width=300
  --   set member(indexfilecast+i).boxtype=#fixed
  --   if j=CharInLine then
  --     set
member(indexfilecast+i).text=largepicturelist[i]
  --   else
  --     set member(indexfilecast+i).text=char j+1 to
CharInLine of member(1,"indexfile").line[i]
  --   end if

```

```

--          exit repeat
--      else
--          exit
--      end if
--      else
--          largepicturelist[i]=largepicturelist[i] & MyChar
--      end if
end repeat
if member(indexfilecast+i).text=empty then
    set member(indexfilecast+i).text=largepicturelist[i]
end if
set the membernum of sprite(startingsprite+i-1) to indexfilecast+i
end repeat
repeat with j=50 to 50+(picnum-1)
    set the visible of sprite (j-34) to true
    set the visible of sprite j to true
    set the visible of sprite(j+20) to true
end repeat
updatestage
end

```

On GetHistoryFile

```

new(#text,member(2,"temp"))
openhstory=new(xtra "fileio")
if fileexists(the moviepath & "history.dat")=0 then
    openfile(openhstory,the moviepath & "history.dat",1)
    set member(2,"temp").text=readfile(openhstory)
    closefile(openhstory)
else
    createfile(openhstory,the moviepath & "history.dat")
end if
set openhstory=0
end

```

On AppendHistoryFile

```

set found=false
delete member(2,"temp").char[member(2,"temp").char.count+1]
AppendHistory=new(xtra "fileio")
if member(2,"temp").text=empty then
    set member(2,"temp").text =member("url").text
else
    if member(2,"temp").line.count=10 then
        if member(2,"temp").line[10].char.count<>0 then
            set member(2,"temp").line[10]=empty
            delete member(2,"temp").char[member(2,"temp").char.count]
        else
            delete member(2,"temp").char[member(2,"temp").char.count]
        end if
    end if
    repeat with i=1 to member(2,"temp").line.count
        if member(2,"temp").line[i]=member("url").text then
            set found=true
            exit repeat
        end if
    end repeat
    if found=false then

```

```

        set member(2,"temp").text= RETURN & member(2,"temp").text
        set member(2,"temp").line[1]=member("url").text
    end if
end if
openfile(Appendhistory,the moviepath & "history.dat",0)
writestring(appendhistory,member(2,"temp").text)
closefile(appendhistory)
end

On HiliteLine LineNum,WhichMember
    if lineNum=1 then
        hilite char 1 to (whichmember.line[1].char.count +1) of field
WhichMember
    else
        set startchar=length(line 1 to LineNum-1 of WhichMember.text)+2
        set endchar=whichmember.line[LineNum].char.count+startchar
        hilite char startchar to endchar of field whichmember
    end if
end

On CheckFile
    repeat with i=1 to the maxinteger
        ChkReqFile=getNthFileNameInFolder(the moviepath,i)
        if ChkReqFile="tms_tool.dll" then
            exit repeat
        else if ChkReqFile=empty then
            alert "A required dll file was not found." & Return & "Please
reinstall Virtual TeleMicroscope."
            quit
        end if
    end repeat
end

On QuitMainMovie
    -- Stuffs to be cleared once exit --
    member(1).erase()
    member(2).erase()
    member(190).erase()
    member(198).erase()
    member(196).erase()
    member(220).erase()
    set castlib("thumbnail").filename=the moviepath & "empty.cst"
    repeat with i=1 to 21
        member(1,"thumbnail").erase()
    end repeat
    quit
end

On QuitPrompt
    set QuitMObj=new(xtra "MUI")
    set QuitMInit=[#buttons:#YesNo,#title:"Quit
Confirmation",#message:"Quit Virtual
Telemicroscope?",#movable:True,#icon:#caution]
    set QuitMAns=Alert(QuitMObj,QuitMInit)
    case QuitMAns of
        1: QuitMainMovie()
    end

```



```

        2: nothing      --continue
        otherwise: abort
    end case
end

```

```

On ClearCast
    set castlib("thumbnail").filename=the moviepath & "empty.cst"
    repeat with i=1 to 21
        member(1,"thumbnail").erase()
    end repeat
end

```

```

On hideAttachFile
    set the visible of sprite(153) to false
    set the visible of sprite(154) to false
    set the visible of sprite(155) to false
    set the visible of sprite(156) to false
end

```

-- Line Measurement For Calibration and Measuring Script --

```

global RulerOn
global ruler
global point1
global point2
global cal
global linelength
global viewerheight
global smallpicheight
global LengthPerPixel
global dropdown
global RefMag
global unit
global PicToScreenRatio

```

```

on mouseDown
    if dropdown=false then
        if RulerOn=false then
            if the visible of sprite 3=true then
                set the visible of sprite 3 to false
                set the visible of sprite 4 to false
            else
                set the visible of sprite 3 to true
                set the visible of sprite 4 to true
            end if
        else
            set the width of sprite(ruler)=1
            set the loc of sprite(ruler)=the mousetloc
            updatestage
            point1=sprite(ruler).loc
            repeat while the stilldown
                point2=the mousetloc
                Hdist=float(point2[2]-point1[2])
                Wdist=float(point2[1]-point1[1])
                if (Hdist>0) and (Wdist>0) then

```

```

    angle=float((atan(hdist/wdist)*180)/pi)
    set the rotation of sprite(ruler)=angle
    updatestage
  else if (Hdist<0) and (Wdist>0) then
    angle=float((atan(hdist/wdist)*180)/pi)
    set the rotation of sprite(ruler)=angle
    updatestage
  else if (Hdist<0) and (Wdist<0) then
    angle=180+float((atan(hdist/wdist)*180)/pi)
    set the rotation of sprite(ruler)=angle
    updatestage
  else if (Hdist>0) and (Wdist<0) then
    angle=180+float((atan(hdist/wdist)*180)/pi)
    set the rotation of sprite(ruler)=angle
    updatestage
  end if
  linelength=sqrt(hdist*hdist+wdist*wdist)
  set the width of sprite(ruler)=linelength
  updatestage
end repeat
end if
end if
end

on Mouseup
  if dropdown=false then
    if (cal=true) and (RulerOn=true) then
      if linelength>0 then
        go to "2-cal_input"
      else
        alert "Please Drag A Line Before Proceeding."
        abort
      end if
    else if (cal=false) and (RulerOn=true) then
      actuallength=linelength*LengthPerPixel*PicToScreenRatio
      set member("result").text=string(actuallength)&&unit
      go to "calibrate"
      updatestage
    end if
  end if
end

on rightmouseup
  if the framelabel="help2" then
    go to "Magnifying"
  else
    go to "help2"
  end if
end

on endsprite
  repeat with i=1 to 50
    set the visible of sprite i to true
  end repeat
end

```

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/27681

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A61B 5/00; G06F 159/00; G06F 9/00; A61B 8/00.

US CL : 600/425,437; 382/132, 133

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 600/425,437; 382/132, 133; 345/127, 129-130, 133, 439

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST, DERWENT

magnify(ing), zoom(ing), internet, network, scale, telepathology, telemedicine, image

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|--------------------------|
| Y | US 5,933,519 A (LEE et al) 03 August 1999, figures 1a-6, 11, and 14, abstract, lines 1-10, col. 1, lines 22-27, 34-44, col. 16, lines 37-58 | 1-58 |
| Y | US 5,954,650 A (SAITO et al) 21 September 1999, figures 1-3, 6, 8, 10, 12-14 | 1-4, 11-13, 20-30, 38-58 |
| Y | US 5,891,035 A (WOOD et al) 06 April 1999, figures 1-3 | 1-58 |
| Y | US 5,542,003 A (WOFFORD) 30 July 1996, figures 6-11 | 31-34, 38 |



Further documents are listed in the continuation of Box C.



See patent family annex.

| | |
|---|--|
| * Special categories of cited documents: | *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| *A* document defining the general state of the art which is not considered to be of particular relevance | *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| *E* earlier document published on or after the international filing date | *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | *&* document member of the same patent family |
| *O* document referring to an oral disclosure, use, exhibition or other means | |
| *P* document published prior to the international filing date but later than the priority date claimed | |

Date of the actual completion of the international search

28 NOVEMBER 2000

Date of mailing of the international search report

04 JAN 2001

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

MICHAEL RAZAVI

Telephone No. (703) 308-4850

PATENT COOPERATION TREATY

0887-4151 PC

Sung ho.

From the INTERNATIONAL SEARCHING AUTHORITY

To: KURT E. RICHTER
MORGAN AND FINNEGAN, L.L. P.
345 PARK AVENUE
NEW YORK, NEW YORK 10154-0053

2001 JAN 10 P 5:24 PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

CASE 0887-4151 PC ATTY SXH
DUE April 4, 2001 (U.S. Suppl. IDS)
1 mo. call-up March 4, 2001
BY J.M.

Date of Mailing
(day/month/year)

04 JAN 2001

Applicant's or agent's file reference
0887-4151PC

FOR FURTHER ACTION See paragraphs 1 and 4 below

International application No.
PCT/US00/27681

International filing date
(day/month/year)
06 OCTOBER 2000

Applicant
THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report; however, for more details, see the notes on the accompanying sheet.

Where? Directly to the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

CASE 0887-4151 PC ATTY SXH

DUE March 4, 2001 (Art. 19)

For more detailed instructions, see the notes on the accompanying sheet.

1 mo. call-up February 4, 2001

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.
☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. Further action(s): The applicant is reminded of the following:

Shortly after 18 months from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in rules 90 bis 1 and 90 bis 3, respectively, before the completion of the technical preparations for international publication.

Within 19 months from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within 20 months from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected in the demand or in a later election within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231
Facsimile No. (703) 305-3230

Authorized officer
MICHAEL RAZAVI

Telephone No. (703) 308-4850

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

| | | |
|--|--|--|
| Applicant's or agent's file reference 0887-4151PC | FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below. | |
| International application No. PCT/US00/27681 | International filing date (day/month/year) 06 OCTOBER 2000 | (Earliest) Priority Date (day/month/year) 08 OCTOBER 1999 |
| Applicant THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK | | |

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
- b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☐ Unity of invention is lacking (See Box II).

4. With regard to the title,

- ☒ the text is approved as submitted by the applicant.
- ☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract,

- ☐ the text is approved as submitted by the applicant.
- ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No. 1

- ☒ as suggested by the applicant.
- ☐ because the applicant failed to suggest a figure.
- ☐ because this figure better characterizes the invention.

☐ None of the figures.

CASE 0887-4151PC ATYSX
DUE February 4, 2001 (Comm. to f
1 mo. call-up January 19, 2001
BY [Signature]

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A method and system that uses a computer system (Fig. 1) as a telemicroscope. A plurality of images of a specimen is captured (Digital camera scanner video camera). The images correspond to the entire specimen and a plurality of segments of the specimen (Multiple linked images). The high-resolution images corresponding to said plurality of segments have different magnification levels and locations (magnifying glass effect); a linking map is generated between said images (Multiple linked images). The linking map comprises information regarding geographical location of the images in relation to the specimen's structure (Image analysis measurement); and images and said linking map are transmitted to a remote user via a computer network thereby allowing the user to view the images with different magnification levels without comprising image clarity (Computer station one and computer station two). The transmitted images are viewed in a dynamic manner, permitting the user to navigate, enlarge, measure, compare, annotate and exam the digitized images on a virtual slides displayed on a computer screen (Image analysis measurement). The operation of the system closely mimics that of a light microscope.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/27681**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : A61B 5/00; G06F 159/00; G06F 9/00; A61B 8/00.

US CL : 600/425,437; 382/132, 133

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 600/425,437; 382/132, 133; 345/127, 129-130, 133, 439

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST, DERWENT

magnify(ing), zoom(ing), internet, network, scale, telepathology, telemedicine, image

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|---|--------------------------|
| Y | US 5,933,519 A (LEE et al) 03 August 1999, figures 1a-6, 11, and 14, abstract, lines 1-10, col. 1, lines 22-27, 34-44, col. 16, lines 37-58 | 1-58 |
| Y | US 5,954,650 A (SAITO et al) 21 September 1999, figures 1-3, 6, 8, 10, 12-14 | 1-4, 11-13, 20-30, 38-58 |
| Y | US 5,891,035 A (WOOD et al) 06 April 1999, figures 1-3 | 1-58 |
| Y | US 5,542,003 A (WOFFORD) 30 July 1996, figures 6-11 | 31-34, 38 |



Further documents are listed in the continuation of Box C.



See patent family annex.

| | |
|---|--|
| * Special categories of cited documents: | *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention |
| *A* document defining the general state of the art which is not considered to be of particular relevance | *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone |
| *B* earlier document published on or after the international filing date | *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art |
| *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) | *Z* document member of the same patent family |
| *O* document referring to an oral disclosure, use, exhibition or other means | |
| *P* document published prior to the international filing date but later than the priority date claimed | |

Date of the actual completion of the international search

28 NOVEMBER 2000

Date of mailing of the international search report

04 JAN 2001

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

MICHAEL RAZAVI

Telephone No. (703) 308-4850

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under Article 19. The Notes are based on the requirements of the Patent Cooperation Treaty and of the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the PCT Applicant's Guide, a publication of WIPO.

In these Notes, "Article", "Rule" and "Section" refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only.

What parts of the international application may be amended ?

The claims only.

The description and the drawings may only be amended during international preliminary examination under Chapter II.

When ? Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments ?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How ? Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Administrative Instructions, Section 205(b)).

What documents must/may accompany the amendments ?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confounded with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must indicate the differences between the claims as filed and the claims as amended. It must, in particular, indicate, in connection with each claim appearing in the international application (it being understood that identical indications concerning several claims may be grouped), whether

- (i) the claim is unchanged;
- (ii) the claim is cancelled;
- (iii) the claim is new;
- (iv) the claim replaces one or more claims as filed;
- (v) the claim is the result of the division of a claim as filed.

NOTES TO FORM PCT/ISA/220 (continued)

The following examples illustrate the manner in which amendments must be explained in the accompanying letter:

1. [Where originally there were 48 claims and after amendment of some claims there are 51]:
"Claims 1 to 29, 31, 32, 34, 35, 37 to 48 replaced by amended claims bearing the same numbers; claims 30, 33 and 36 unchanged; new claims 49 to 51 added."
2. [Where originally there were 15 claims and after amendment of all claims there are 11]:
"Claims 1 to 15 replaced by amended claims 1 to 11."
3. [Where originally there were 14 claims and the amendments consist in cancelling some claims and in adding new claims]:
"Claims 1 to 6 and 14 unchanged; claims 7 to 13 cancelled; new claims 15, 16 and 17 added." or
"Claims 7 to 13 cancelled; new claims 15, 16 and 17 added; all other claims unchanged."
4. [Where various kinds of amendments are made]:
"Claims 1-10 unchanged; claims 11 to 13, 18 and 19 cancelled; claims 14, 15 and 16 replaced by amended claim 14; claim 17 subdivided into amended claims 15, 16 and 17; new claims 20 and 21 added."

"Statement under Article 19(1)" (Rule 46.4)

The amendments may be accompanied by a statement explaining the amendments and indicating any impact that such amendments might have on the description and the drawings (which cannot be amended under Article 19(1)).

The statement will be published with the international application and the amended claims.

The statement should be brief, it should not exceed 500 words if in English or if translated into English.

It should not be confounded with and does not replace the letter indicating the differences between the claims as filed and as amended. It must be filed on a separate sheet and must be identified as such by a heading, preferably by using the words "Statement under Article 19(1)."

It should not contain any disparaging comments on the international search report or the relevance of citations contained in that report. Reference to citations, relevant to a given claim, contained in the international search report may be made only in connection with an amendment of that claim.

In what language ?

The amendments must be made in the language in which the international application is published. The letter and any statement accompanying the amendments must be in the same language as the international application if that language is English or French; otherwise, it must be in English or French, at the choice of the applicant.

Consequence if a demand for international preliminary examination has already been filed ?

If, at the time of filing any amendments under Article 19, a demand for international preliminary examination has already been submitted, the applicant must preferably, at the same time of filing the amendments with the International Bureau, also file a copy of such amendments with the International Preliminary Examining Authority (see Rule 62.2(a), first sentence).

Consequence with regard to translation of the international application for entry into the national phase ?

The applicant's attention is drawn to the fact that, where upon entry into the national phase, a translation of the claims as amended under Article 19 may have to be furnished to the designated/elected Offices, instead of, or in addition to, the translation of the claims as filed.

For further details on the requirements of each designated/elected Office, see Volume II of the PCT Applicant's Guide.

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: KURT E. RICHTER
MORGAN AND FINNEGAN, L.L. P.
345 PARK AVENUE
NEW YORK, NEW YORK 10154-0053

PCT

NOTIFICATION OF CHANGE IN
ABSTRACT AS PREVIOUSLY ESTABLISHED
BY INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 38.2(b)
and Administrative Instructions, Section 515)

Date of Mailing
(day/month/year)

06 JUN 2001

Applicant's or agent's file reference

0887-4151PC

INFORMATION ONLY

International application No.

PCT/US00/27681

International filing date
(day/month/year)

06 OCTOBER 2000

Applicant

THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK

The applicant is hereby notified that this International Search Authority has considered the comments received from the applicant on the abstract established by this Authority (Form PCT/ISA/210) and has decided that:

☐ the text of the abstract remains as previously established by this Authority for the reasons indicated below/in the Annex.

☒ the text of the abstract is changed in view of the applicant's comments and it now reads as it appears below/in the Annex.

A method and system that uses a computer system as a telemicroscope. A plurality of images of a specimen is captured (Digital camera, scanner, video camera). The images correspond to the entire specimen and a plurality of segments of the specimen (Multiple linked images). The high-resolution images corresponding to said plurality of segments have different magnification levels and locations (magnifying glass effect); a linking map is generated between said images (Multiple linked images). The linking map comprises information regarding geographical location of the images in relation to the specimen's structure (Image analysis measurement); and images and said linking map are transmitted to a remote user via a computer network thereby allowing the user to view the images with different magnification levels without compromising image clarity (Computer station one and computer station two). The transmitted images are viewed in a dynamic manner, permitting the user to navigate, enlarge, measure, compare, annotate and examine the digitized images on a virtual slides displayed on a computer screen (Image analysis measurement). The operation of the system closely mimics that of a light microscope.

A copy of this Notification and any Annex has been sent to the International Bureau.

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

MICHAEL RAZAVI

Telephone No. (703) 508-4860

Rugenia Logan

PATENT COOPERATION TREATY

RECEIVED
BUCKET DEPT.

0887-4151 PC
Hong

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To: KURT E. RICHTER
MORGAN AND FINNEGAN, L.L.P.
345 PARK AVENUE
NEW YORK, NEW YORK 10154-0053

2001 AUG 31 A 11:30 PCT

ORGAN & FINNEGAN
WRITTEN OPINION
(PCT Rule 66)

Date of Mailing
(day/month/year)

27 AUG 2001

Applicant's or agent's file reference

0887-4151

REPLY DUE

within TWO months
from the above date of mailing

Internal

No.

International filing date (day/month/year)

06 OCTOBER 2000

Priority date (day/month/year)

08 OCTOBER 1999

National Patent Classification (IPC) or both national classification and IPC
See Supplemental Sheet.

Applicant

THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK

1. This written opinion is the first (first, etc.) drawn by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

CASE 0887-4151 PC ATTY SX/H
DUE October 27, 2001 (with opin.)
1 mo. call-up September 27, 2001

3. The applicant is hereby invited to reply to this opinion.

When? See the time limit indicated above. ~~The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).~~

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also For an additional opportunity to submit amendments, see Rule 66.4. For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis. For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 08 FEBRUARY 2002

Name and mailing address of the IPEA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

MICHAEL RAZAVI

Telephone No. (703) 305-4850

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

PCT

WRITTEN OPINION

(PCT Rule 66)

To: KURT E. RICHTER
MORGAN AND FINNEGAN, L.L. P.
345 PARK AVENUE
NEW YORK, NEW YORK 10154-0053

Date of Mailing
(day/month/year)

27 AUG 2001

Applicant's or agent's file reference
0887-4151PC

REPLY DUE within TWO months
from the above date of mailing

International application No.
PCT/US00/27681

International filing date (day/month/year)
06 OCTOBER 2000

Priority date (day/month/year)
08 OCTOBER 1999

International Patent Classification (IPC) or both national classification and IPC
Please See Supplemental Sheet.

Applicant
THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK

1. This written opinion is the first (first, etc.) drawn by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

- I ☒ Basis of the opinion
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

3. The applicant is hereby invited to reply to this opinion.

When? See the time limit indicated above. ~~The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).~~

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 08 FEBRUARY 2002

Name and mailing address of the IPEA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

MICHAEL KAZAVI

Telephone No. (703) 306-4850

I. Basis of the opinion

1. With regard to the elements of the international application: *

☒ the international application as originally filed☒ the description:

pages 1-32, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

☒ the claims:

pages 33-44, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages NONE, filed with the letter of

☒ the drawings:

pages 1-21, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

☒ the sequence listing part of the description:

pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☒ the description, pages NONE
☒ the claims, Nos. NONE
☒ the drawings, sheets/fig. NONE

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

| | | | |
|-------------------------------|--------|---------------------------------|-----|
| Novelty (N) | Claims | (Please See supplemental sheet) | YES |
| | Claims | (Please See supplemental sheet) | NO |
| Inventive Step (IS) | Claims | (Please See supplemental sheet) | YES |
| | Claims | (Please See supplemental sheet) | NO |
| Industrial Applicability (IA) | Claims | (Please See supplemental sheet) | YES |
| | Claims | (Please See supplemental sheet) | NO |

2. citations and explanations

Claims 1-4, 13-14, 20, 26-30, 38, 43, and 47-53 lack novelty under PCT Article 33(2) as being anticipated by KAMENTSKY et al US Patent No. 5,793,969.

KAMENTSKY et al disclose

Claims 1-4, 13-15, 18, 20, 26-35, 38-41, 43-45, and 47-53 lack novelty under PCT Article 33(2) as being anticipated by KAMENTSKY et al US Patent No. 5,793,969.

KAMENTSKY et al teach a digital image capturing device of a first image (see figures 2-4, column 1, line 66 to column 2, line 8), teach a digital image capturing device of a second image with a different magnification than the first image (see figures 2-4), storage of the first and second images in a computer-readable medium (see figures 2-4, column 1, line 66 to column 2, line 8), a linking information map indicating the relationship between the first and second images (see figures 2-4), the computer readable medium is one of computer hard-drive, portable disk or CD (see figures 2-4, column 7, lines 66-67), network file server relating to a retrievable index file stored on a computer readable medium (see abstract, lines 5-23), displaying on a monitor screen a listing of the plurality of image files (see figures 2-4, abstract, lines 5-23), dynamically displaying the first and second file name allowing a user to view the specimen with different magnification levels of the specimen (see figures 2-4, column 1, lines 7-11), the location of the file is selected from a group consisting of an Internet URL, a path of an intranet, and a local file (see abstract, lines 1-7, and column 3, lines 4-23), the tool bar provides a magnifying means (see figures 2-3), the magnifying means provides varied levels of magnification 10x, 20x, and 40x (see figures 2-4), dynamically displaying the image on entire screen (see figures 2-4), microscopic slides relate to the virtual slides (see abstract, lines 1-4), movable sliding means, transmitting said images (see abstract, lines 10-13), and encoded microscope slides relate to the means of encrypting said images (see abstract, lines 1-4), network encoder system relate to a processing unit (Continued on Supplemental Sheet.)

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 56 has a typing error on line one. "the words linkage and therapy are joined as one word. Claim 56 was evaluated as best understood.

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Sheet 10

Continuation of: Boxes I - VIII

TIME LIMIT:

The time limit set for response to a Written Opinion may not be extended. 37 CFR 1.484(d). Any response received after the expiration of the time limit set in the Written Opinion will not be considered in preparing the International Preliminary Examination Report.

CLASSIFICATION:

The International Patent Classification (IPC) and/or the National classification are as listed below:
IPC(7): A61B 5/00; GO6F 159:00; GO6F 9/00; A61B 8/00; GO6F 17/30, 15/167; HO4N 7/18 and US Cl.: 600/425,437; 382/132, 133; 707/6; 709/213; 348/79

V. 1. REASONED STATEMENTS:

The opinion as to Novelty was positive (YES) with respect to claims 5-12, 16-17, 19, 21-25, 36-37, 42, 46, and 54-58.
The opinion as to Novelty was negative (NO) with respect to claims 1-4, 13-15, 18, 20, 26-35, 38-41, 43-45, AND 47-53.
The opinion as to Inventive Step was positive (YES) with respect to claims NONE.
The opinion as to Inventive Step was negative (NO) with respect to claims 1-58.
The opinion as to Industrial Applicability was positive (YES) with respect to claims 1-58.
The opinion as to Industrial Applicability was negative (NO) with respect to claims NONE.

V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):
and in communication with a memory unit (see column 6, lines 54-66).

Claims 5-12, 17, 19, 22, 23-25, 36-37, 46, and 54-58 lack an inventive step under PCT Article 33(3) as being obvious over KAMENTSKY et al US Patent No. 5,793,969 in view of JAIN et al US Patent No. 5,893,095. KAMENTSKY et al disclose wherein the storing of said first and second images of the information map in a computer-readable medium, utilizes the means of a digital camera (see column 1, line 66 to column 2, line 8), does not disclose the means of one of JPG, GIF, TIF, or BMP, a scanner device, web server. JAIN et al disclose the means of one of JPG, GIF, TIF, or BMP (see column 29, line 64), a scanner device (see figure 1B, element 156), web server (see column 27, line 43), custom primitive addresses can utilize any image understanding technique i.e., measurement function (see abstract, lines 5-7, and 19-21). It would have been obvious to one at the time of the invention to utilize the JPG, scanner and web server mechanism allowing for content-based search and retrieval of visual objects (see abstract, lines 1-2) of JAIN et al with the network system of review and analysis of computer encoded microscopic slides and specimens which were originally encoded from a microscope of KAMENTSKY et al because both inventions teach image comparison and image analysis of files collected from the means of a database/network system. In other words, the application of visual information management (see JAIN et al column 1, lines 28-36).

Claims 16, 21, and 42 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of WEINSTEIN US Patent No. 5,216,596. KAMENTSKY et al US Patent No. 5,793,969 in view of JAIN et al US Patent No. 5,893,095 do not disclose a network for allowing a remote user means, e-mail means. WEINSTEIN et al disclose remote user means (see abstract, lines 1-3), and e-mail means (see figures 2-5, column 6, lines 32-37). It would have been obvious to one at the time of the invention to utilize the "Telepathology Diagnostic Network" including the remote user means, and e-mail means of WEINSTEIN with the modified application of visual information management of KAMENTSKY et al because WEINSTEIN's pathology diagnostic device increases user operability of the modified device of KAMENTSKY with the addition of a remote access and utilization of e-mail capability.

----- NEW CITATIONS -----

US 5,793,969 A (KAMENTSKY et al) 11 AUGUST 1998, see figures 2-4, abstract, lines 1-4, 5-23, 10-13, column 1, lines 7-11, 66-67, column 2, lines 1-8, column 3, lines 4-23, column 6, lines 54-66, column 7, lines 66-67.

US 5,893,095 A (JAIN et al) 06 APRIL 1999, see figure 1B, element 156, abstract, lines 5-7, 19-21, column 1, lines 28-36,

Supplemental Box . .

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

Sheet 11

column 27, line 43, column 29, line 64.

US 5,216,596 A (WEINSTEIN) 01 JUNE 1993, see figures 2-5, abstract, lines 1-3, column 6, lines 32-37.

CORRECTED VERSION

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
19 April 2001 (19.04.2001)

PCT

(10) International Publication Number
WO 01/26541 A1

(51) International Patent Classification⁷: **A61B 5/00**,
G06F 159/00, 9/00, A61B 8/00

5453 Old Shell Road, Apartment 108, Mobile, AL 36608
(US). ANDERSON, Virginia, M. [US/US]; 10 Warren
Street, Rumson, NJ 07760 (US).

(21) International Application Number: PCT/US00/27681

(22) International Filing Date: 6 October 2000 (06.10.2000)

(74) Agents: **RICHTER, Kurt, E.** et al.; Morgan & Finnegan,
L.L.P., 345 Park Avenue, New York, NY 10154-0053 (US).

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/158,326 8 October 1999 (08.10.1999) US

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,
AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE,
DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU,
ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS,
LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO,
NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR,
TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(71) Applicant (*for all designated States except US*): **THE RE-
SEARCH FOUNDATION OF STATE UNIVERSITY
OF NEW YORK** [US/US]; Technology Transfer Office,
P.O. Box 9, Albany, NY 12201-0009 (US).

(84) Designated States (*regional*): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,
IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG,
CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

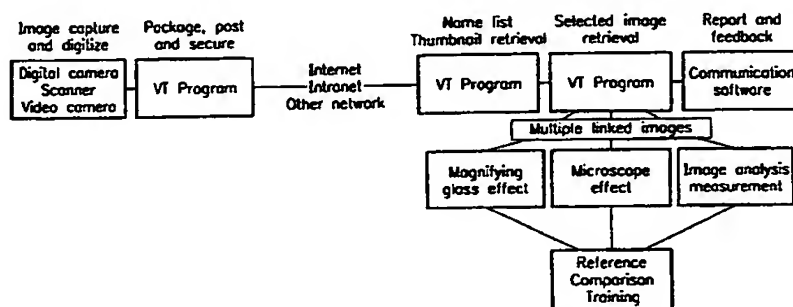
(72) Inventors; and

(75) Inventors/Applicants (*for US only*): **GU, Jiang** [CN/US];

[Continued on next page]

(54) Title: **VIRTUAL TELEMICROSCOPE**

Principle of the Virtual Telemicroscope System



Computer station one

Computer station two

Note: Functions of the two computers can be reversed. Both can send and receive images.

(57) Abstract: A method and system that uses a computer system as a telemicroscope. A plurality of images of a specimen is captured (Digital camera, scanner, video camera). The images correspond to the entire specimen and a plurality of segments of the specimen (Multiple linked images). The high-resolution images corresponding to said plurality of segments have different magnification levels and locations (magnifying glass effect); a linking map is generated between said images (Multiple linked images). The linking map comprises information regarding geographical location of the images in relation to the specimen's structure (Image analysis measurement); and images and said linking map are transmitted to a remote user via a computer network thereby allowing the user to view the images with different magnification levels without compromising in image clarity (Computer station one and computer station two). The transmitted images are viewed in a dynamic manner, permitting the user to navigate, enlarge, measure, compare, annotate and exam the digitized images on a virtual slides displayed on a computer screen (Image analysis measurement). The operation of the system closely mimics that of a light microscope.

WO 01/26541 A1



Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(48) Date of publication of this corrected version:

18 October 2001

(15) Information about Correction:

see PCT Gazette No. 42/2001 of 18 October 2001, Section

II

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

REC'D 18 JUN 2002

WIPO

PCT

(PCT Article 36 and Rule 70)

| | | |
|--|--|---|
| Applicant's or agent's file reference 0887-4151PC | FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) | |
| International application No. PCT/US00/27681 | International filing date (day/month/year) 06 OCTOBER 2000 | Priority date (day/month/year) 08 OCTOBER 1999 |
| International Patent Classification (IPC) or national classification and IPC Please See Supplemental Sheet. | | |
| Applicant THE RESEARCH FOUNDATION OF STATE UNIVERSITY OF NEW YORK | | |

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability, citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☒ Certain observations on the international application

| | |
|--|---|
| Date of submission of the demand 07 MAY 2001 | Date of completion of this report 31 MAY 2002 |
| Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 | Authorized officer MICHAEL RAZAVI <i>Rugenia Zogan</i> |
| Facsimile No. (703) 305-3230 | Telephone No. (703) 308-4850 |

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/27681

I. Basis of the report

1. With regard to the elements of the international application:*

☒ the international application as originally filed☒ the description:

pages 1-32, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

☒ the claims:

pages 33-44, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages NONE, filed with the letter of

☒ the drawings:

pages 1-21, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

☒ the sequence listing part of the description:

pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).☐ the language of publication of the international application (under Rule 48.3(b)).☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.☐ filed together with the international application in computer readable form.☐ furnished subsequently to this Authority in written form.☐ furnished subsequently to this Authority in computer readable form.☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.4. ☒ The amendments have resulted in the cancellation of:☒ the description, pages NONE☒ the claims, Nos. NONE☒ the drawings, sheets/fig. NONE5. ☐ This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/27681

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

| | | | |
|-------------------------------|--------|---------------------------------|-----|
| Novelty (N) | Claims | (Please See supplemental sheet) | YES |
| | Claims | (Please See supplemental sheet) | NO |
| Inventive Step (IS) | Claims | (Please See supplemental sheet) | YES |
| | Claims | (Please See supplemental sheet) | NO |
| Industrial Applicability (IA) | Claims | (Please See supplemental sheet) | YES |
| | Claims | (Please See supplemental sheet) | NO |

2. citations and explanations (Rule 70.7)

Claims 1-4, 13-14, 20, 26-30, 38, 43, and 47-53 lack novelty under PCT Article 33(2) as being anticipated by KAMENTSKY et al US Patent No. 5,793,969.

KAMENTSKY et al disclose

Claims 1-4, 13-15, 18, 20, 26-35, 38-41, 43-45, and 47-53 lack novelty under PCT Article 33(2) as being anticipated by KAMENTSKY et al US Patent No. 5,793,969.

KAMENTSKY et al teach a digital image capturing device of a first image (see figures 2-4, column 1, line 66 to column 2, line 8), teach a digital image capturing device of a second image with a different magnification than the first image (see figures 2-4), storage of the first and second images in a computer-readable medium (see figures 2-4, column 1, line 66 to column 2, line 8), a linking information map indicating the relationship between the first and second images (see figures 2-4), the computer readable medium is one of computer hard-drive, portable disk or CD (see figures 2-4, column 7, lines 66-67), network file server relating to a retrievable index file stored on a computer readable medium (see abstract, lines 5-23), displaying on a monitor screen a listing of the plurality of image files (see figures 2-4, abstract, lines 5-23), dynamically displaying the first and second file name allowing a user to view the specimen with different magnification levels of the specimen (see figures 2-4, column 1, lines 7-11), the location of the file is selected from a group consisting of an Internet URL, a path of an intranet, and a local file (see abstract, lines 1-7, and column 3, lines 4-23), the tool bar provides a magnifying means (see figures 2-3), the magnifying means provides varied levels of magnification 10x, 20x, and 40x (see figures 2-4), dynamically displaying the image on entire screen (see figures 2-4), microscopic slides relate to the virtual slides (see abstract, lines 1-4), movable sliding means, transmitting said images (see abstract, lines 10-13), and encoded microscope slides relate to the means of encrypting said images (see abstract, lines 1-4), network encoder system relate to a processing unit (Continued on Supplemental Sheet.)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/27681

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claim 56 has a typing error on line one. "the words linkage and therapy are joined as one word. Claim 56 was evaluated as best understood.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/US00/27681

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

Sheet 10

CLASSIFICATION:

The International Patent Classification (IPC) and/or the National classification are as listed below:
 IPC(7): A61B 5/00; G06F 15/00; G06F 9/00; A61B 8/00; G06F 17/30, 15/167; HO4N 7/18 and US Cl.: 600/425,437; 382/132, 133; 707/6; 709/213; 348/79

V. 1. REASONED STATEMENTS:

The report as to Novelty was positive (YES) with respect to claims 5-12, 16-17, 19, 21-25, 36-37, 42, 46, and 54-58.
 The report as to Novelty was negative (NO) with respect to claims 1-4, 13-15, 18, 20, 26-35, 38-41, 43-45, AND 47-53.
 The report as to Inventive Step was positive (YES) with respect to claims NONE.
 The report as to Inventive Step was negative (NO) with respect to claims 1-58.
 The report as to Industrial Applicability was positive (YES) with respect to claims 1-58.
 The report as to Industrial Applicability was negative (NO) with respect to claims NONE.

V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):

and in communication with a memory unit (see column 6, lines 54-66).

Claims 5-12, 17, 19, 22, 23-25, 36-37, 46, and 54-58 lack an inventive step under PCT Article 33(3) as being obvious over KAMENSKY et al US Patent No. 5,793,969 in view of JAIN et al US Patent No. 5,893,095. KAMENSKY et al disclose wherein the storing of said first and second images of the information map in a computer-readable medium, utilizes the means of a digital camera (see column 1, line 66 to column 2, line 8), does not disclose the means of one of JPG, GIF, TIF, or BMP, a scanner device, web server. JAIN et al disclose the means of one of JPG, GIF, TIF, or BMP (see column 29, line 64), a scanner device (see figure 1B, element 156), web server (see column 27, line 43), custom primitive addresses can utilize any image understanding technique i.e., measurement function (see abstract, lines 5-7, and 19-21). It would have been obvious to one at the time of the invention to utilize the JPG, scanner and web server mechanism allowing for content-based search and retrieval of visual objects (see abstract, lines 1-2) of JAIN et al with the network system of review and analysis of computer encoded microscopic slides and specimens which were originally encoded from a microscope of KAMENSKY et al because both inventions teach image comparison and image analysis of files collected from the means of a database/network system. In other words, the application of visual information management (see JAIN et al column 1, lines 28-36).

Claims 16, 21, and 42 lack an inventive step under PCT Article 33(3) as being obvious over the prior art as applied in the immediately preceding paragraph and further in view of WEINSTEIN US Patent No. 5,216,596. KAMENSKY et al US Patent No. 5,793,969 in view of JAIN et al US Patent No. 5,893,095 do not disclose a network for allowing a remote user means, e-mail means. WEINSTEIN et al disclose remote user means (see abstract, lines 1-3), and e-mail means (see figures 2-5, column 6, lines 32-37). It would have been obvious to one at the time of the invention to utilize the "Telepathology Diagnostic Network" including the remote user means, and e-mail means of WEINSTEIN with the modified application of visual information management of KAMENSKY et al because WEINSTEIN's pathology diagnostic device increases user operability of the modified device of KAMENSKY with the addition of a remote access and utilization of e-mail capability.

----- NEW CITATIONS -----

US 5,793,969 A (KAMENSKY et al) 11 AUGUST 1998. see figures 2-4, abstract, lines 1-4, 5-23, 10-13, column 1, lines 7-11, 66-67, column 2, lines 1-8, column 3, lines 4-23, column 6, lines 54-66, column 7, lines 66-67.

US 5,893,095 A (JAIN et al) 06 APRIL 1999. see figure 1B, element 156, abstract, lines 5-7, 19-21, column 1, lines 28-36, column 27, line 43, column 29, line 64.

US 5,216,596 A (WEINSTEIN) 01 JUNE 1993. see figures 2-5, abstract, lines 1-3, column 6, lines 32-37.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☒ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.